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MARINE AND SHIPBUILDING

UDC 629.12.030843.6.001.63

CHOOSING POWER PLANTS FOR HIGH-SPEED AND LARGE-DISPLACEMENT SHIPS

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 81 pp 22-27

SEDAKOV, L. P. and YELISTRATOZ, F. M.

[Abstract] An analysis is made of factors that determine selection of power plants for container ships, lighters, gas and oil tankers, bulk carriers, and ships with horizontal cargo handling. The analysis is based on a study of 12 types of ships with deadweights up to 150,000 metric tons, displacements up to 125,000 cu. m and speeds from 15 to 26.5 knots. Eight types of power plants are considered with different combinations of medium-speed and low-speed diesels, gas and steam turbines, utilization facilities, intermediate steam superheating, and with fixed and variable screws as well as twin-screw propulsion. The results of this study show that for most types of ships considered, power plants should be based on medium-rpm and low-rpm diesel engines with high fuel economy. Steam turbine plants may be the most efficient for vessels that require power of 30,000-37,000 kW. Figures 3, tables 4, references 7: 4 Russian, 3 Western.

[67-6610]

UDC 629.12.03-887.001.5

ANALYZING WORKING CONDITIONS OF MULTIPLE-ENGINE MARINE POWER PLANT

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 81 pp 29-32

GLUSHKOZ, S. P.

[Abstract] Methods of the theory of multidimensional automatic systems are applied to analysis of the internal connections in multiple-engine marine power plants as exemplified by a multiple-shaft unit consisting of several engines, each of which drives a fixed-pitch screw through a reducing gear. Analytical relations are derived for the principal relations between parameters of the propulsion unit during maneuvering, and an estimate is made of the

effectiveness of internal connections between individual components of the propulsion unit. It is found that parallel operation of engines in such a system gives rise to additional direct cross connections that transfer signals circulating in one channel to another channel. The major quality indicators of the transient process in these additional connections are its duration and the maximum absolute deviations of output coordinates from their new steady-state values. These parameters are determined by a time constant and influence factors that can be calculated from the characteristics of propulsion unit components. The speed of maneuvering of parallel engines does not have any appreciable effect on transient processes of adjacent engines since cross connections within the propulsion unit are made through the hull, which has large inertia. On the other hand, in simultaneous maneuvering of engines the torque load depends on the extent to which the control processes of adjacent engines are out of sync (control signal delay). The follow-the-leader principle of synchronizing shaft rpm inevitably leads to a static error that depends on the static and dynamic characteristics of the propulsion unit components and the initial mismatch of shaft speeds. Therefore additional correcting signals must be used. Figures 6, references 5 Russian.

[67-6610]

NUCLEAR ENERGY

UDC 621.039.63:661.66.665

USE OF GRAPHITE AND METAL CARBIDES AS MATERIALS FOR LIMITER, SHIELD AND
INJECTOR PLATES IN FUSION REACTORS

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 4, Oct 81
(manuscript received 7 Jul 80) pp 247-252

GUSEVA, M. I., ZAKHAROV, A. P., IONOVA, Ye. S., MARTYNENKO, Yu. V.,
NIKOL'SKIY, Yu. V., STEPANCHIKOV, V. A., REPNIKOV, N. N., CHUZHKO, R. K.
and GORODETSKIY, A. Ye.

[Abstract] In order to protect the first wall of a fusion reactor against cyclic action of electromagnetic and particle beams coming from the plasma, it is necessary to select refractory materials for the limiter and shield as well as for the injector plates which have adequate thermal conductivity and can withstand thermal shock due to forced cooling. They must also have high erosion resistance and thus the smallest possible SZ^2 product (Z- atomic number, S- total rate of erosion due to atomization, blistering and evaporation). Hydrogen embrittlement must furthermore be avoided by ensuring adequate electrical conductivity. Graphite coated with a strongly adhering layer of metal carbide has been considered for this application. A study was made to determine the pertinent characteristics, especially the radiative surface erosion, of extra-pure graphite and WCA graphite cloth alone and coated with tantalum carbide or niobium carbide. Surface microstructure after irradiation and bombardment was examined under electron microscope, erosion was measured by the weighing method, and phase composition was analyzed by Auger-electron spectroscopy with a model PHI-545 Physical Electronics Industrial Co. instrument. The results indicate that the two carbides adhere strongly to a graphite substrate and have high erosion resistance under hydrogen and helium bombardment at 1000°C, the C-NbC composite being preferable because of its approximately four times lower SZ^2 product. Further studies are required, however, especially of blistering under more intense irradiation and at higher temperatures. An evaluation study of titanium carbide on graphite is already underway. Figures 7, tables 2, references 18: 4 Russian, 14 Western.
[83-2415]

UDC 539.171.017

CROSS SECTIONS FOR ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS BY
INDIUM ISOTOPES

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 4, Oct 81
(manuscript received 20 Jan 81, in final version 10 Mar 81) pp 244-247

SIMAKOV, S. P., LOVCHIKOVA, G. N., SAL'NIKOV, O. A., TRUFANOV, A. M.,
KOTEL'NIKOVA, G. V. and SHCHADIN, N. N.

[Abstract] An experimental study was made to determine the cross sections for elastic and inelastic scattering of high-energy neutrons by In¹¹³ and In¹¹⁵ isotopes. Measurements were made by a time-of-flight method, with a gaseous tritium target bombarded by a proton beam from the EGP-10M accelerator serving as a source of monoenergetic neutrons. The instrumentation included a detector, scintillation monitor, photomultiplier, discriminators, pulse counter, logic and control. The initial neutron energy levels for these measurements were 6.47±0.07 MeV, 7.49±0.08 MeV, 8.53±0.11 MeV prior to scattering by an In¹¹³ + In¹¹⁵ mixture and 5.19±0.06 MeV prior to scattering by In¹¹⁵. The data have been processed in terms of differential cross sections for elastic scattering by In¹¹³ + In¹¹⁵ and by In¹¹⁵ respectively, that for elastic scattering by In¹¹³ being calculated from the other two. Some degree of indeterminacy in fixing the scatter angle and in separating elastic from inelastic scattering was inevitable, due to instrumental inaccuracy. The results of this study are nevertheless fairly consistent with earlier data obtained by other authors. With a Maxwell distribution approximating the energy spectrum of scattered neutrons, moreover, the results can be extrapolated into the low-energy range, below the 0.6 MeV experimental threshold, for estimating the total cross sections for inelastic scattering. Figures 3, tables 2, references 14: 6 Russian, 8 Western.
[83-2415]

UDC 621.311.25:621.039.004.17

EXPERIENCE IN INTRODUCTION AND OPERATION OF THIRD POWER UNIT WITH FAST
REACTOR IN BELOYARSKAYA ATOMIC ELECTRIC POWER PLANT

Moscow ELEKTRICHESKIE STANTSII in Russian No 9, Sep 81 pp 12-17

KUPNYY, V. I., engineer, and BUDZIYEVSKIY, V. V., engineer, Beloyarskaya Atomic
Electric Power Plant

[Abstract] Power unit No 3 in the Beloyarskaya atomic electric power plant has an installed capacity of 600 MW electric power. It includes a BN-600 fast reactor with three loops, using liquid sodium coolant in the first two and water (steam) in the third. There follow three stages: a PGN-200M segmental steam generator with capacity of 600 t/h (140 kgf/cm², 505°C), a K-200-130 turbine, and a TGV-200M electric generator. Also included are a deaerator and three

electric pumps. The operation is controlled by a "Kompleks-Uran" measuring-and-information system with M-7000 computer and "Orion" display panel. The power unit has been in operation since 8 April 1980. During the introductory period all equipment, including automatic regulation and protective interlocking, was tested completely and adjusted to system load and demand curves. Special attention was paid to both fast and slow reactor fault protection. During a subsequent shutdown from 14 May to 15 June all auxiliary equipment in the heat system was checked, modified and overhauled. The reactor was then broken in for operation by stepwise increases of its power: 40% nominal on 15 June, 50.6% nominal on June 21, 70% nominal on 22 August, 80% nominal on 16 September. Another shutdown for preventive maintenance occurred on 3 October. As of 6 April 1981 the power unit has been in actual operation for 240 days and delivered 1,841.522 million kWh, the reactor having operated for 147 effective days with its fuel depletion reaching 3.5%. The success of this project is due to the efforts of Yu. D. Krutikov (senior operator in No 2 reactor workshop), Yu. P. Fitsko (senior mechanic in No 2 turbine workshop), L. V. Okulov (electrician in the electrical workshop), V. N. Malygin (machinist in the heat system automation workshop), V. I. Batanov (shift foreman in the electrical workshop) and V. I. Anikin (foreman of plant shift). Figures 7. [60-2415]

UDC 621.311.25:621.039.001.13

METHOD OF BOOSTING STEAM-TURBINE UNITS IN ATOMIC ELECTRIC POWER PLANTS

Minsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: ENERGETIKA in Russian No 7, Jul 81 (manuscript received 10 Nov 80) pp 106-108

KHRUSTALEV, V. A., candidate of technical sciences, and PETIN, S. M., engineer, Chair of Thermal Electric Power Plants, "Order of Labor's Red Banner" Saratov Polytechnic Institute

[Abstract] A method of boosting a steam turbine with a gas turbine for peak-load operation in an atomic electric power plant is described which essentially involves displacement of steam-steam superheat in the separator by heat from flue gases. This does not require boosting the reactor, but does require means of supplying fresh makeup steam. Calculations of power balance and losses indicate that the capacity of K-1000-60/1500 and K-1000-65/1500 steam turbines can thus be boosted by 70-75 MW. It is preferable to boost by raising pressure before the turbine rather than through external bypassing or with initial throttling. Figures 4, references 2 Russian.
[50-2415]

FLEXIBLE ATOMIC ELECTRIC POWER PLANTS WITH HEAT STORAGE DEVICES

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 24 Sep 80) pp 153-157

BOLDYREV, V. M., VORONKOV, M. Ye., SINEV, N. M. and CHAKHOVSKIY, V. M.

[Abstract] Atomic electric power plants of the condensation type and the thermal type which are now being built and installed will after the year 1990, according to experts, not be able to operate continuously in the base mode and require a 15-25% load reduction during the night shift in the Unified Central and the Unified Northwestern power systems. The major problems arising with variable operation are lower reliability combined with higher cost and nonsteady poisoning of the core by Xe^{135} isotope. A possible remedy ensuring the necessary flexibility of such a power plant is inclusion of a peak-load covering stage with heat storage devices. Four such schemes have been developed by the authors for a power plant with a VVER-1000 water-moderated water-cooled power reactor: one including a low-pressure feedwater tank made of prestressed reinforced concrete, one including a high-pressure feedwater tank with steam displacement to a deaerator and with a high-pressure preheater. The third scheme involves an autonomous peak stage with a steam-water tank for heat storage. The fourth scheme involves a phase-transition tank utilizing the latent heat of fusion of heat-storing substances such as salt eutectics or bimetallic compounds. All four schemes have been evaluated in terms of overall performance characteristics. Although steam-water tanks for heat storage offer a much wider range of power regulation, feedwater tanks are recommended for immediate installation on account of their simplicity, reliability and cost effectiveness. Figures 4, table 1, references 5 Russian.

[49-2415]

TESTS OF RBMK-1500 FUEL ASSEMBLIES IN WATER-GRAPHITE CHANNEL REACTOR OF LENINGRAD ATOMIC ELECTRIC PLANT

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 24 Sep 80) pp 150-153

ADEN, V. G., VAROVIN, I. A., VORONTSOV, B. A., GARUSOV, Yu. V.,
YEPPERIN, A. P., KUDRYAVTSEV, Yu. V., OSMACHKIN, V. S., RURA, N. N.,
RYABOV, V. I., RYABOV, A. N., CHERNOBAYEV, V. Yu., FEDULENKO, V. M. and
FILIPPOV, V. N.

[Abstract] A series of tests was performed on RBMK-1500 fuel assemblies in the water-graphite channel reactor of the Leningrad atomic electric power plant, to determine their thermophysical characteristics and maximum power capacity.

These assemblies have been designed for a 50% higher capacity at a lower coolant flowrate than that of the RBMK-1000. The performance levels in the experiment were made to approach the critical ones as closely as possible without causing the heat transfer to become critical. Safety of the experiment was checked by varying the coolant flowrate at constant power down to the lowest permissible level and holding it for limited periods of time, i.e., till the temperature rise reached 10-15°C. The test procedure consisted of two stages, following preliminary adjustments and calibration of the recording instruments for accuracy. First the thermotechnical characteristics of an assembly with and without heat transfer intensifiers were measured and compared, at power levels not exceeding the nominal 3 MW for a standard RBMK-1000, then the assemblies were tested at the maximum permissible power level with a 6.5% higher uranium enrichment. The assemblies were found to have withstood these tests in terms of retaining gas tightness and otherwise. Subsequent calculations of the critical thermal flux density, based on theoretical relations and experimental data, have established that an RBMK-1500 assembly has a maximum capacity of 4,720 kW and requires at that level 20.5 metric tons of coolant per hour with 49 wt.% vapor content at the outlet. This corresponds to a reactor output of 900 MW of electric power. Figures 5, references 3 Russian.

[49-2415]

UDC 621.3.078

PERFORMANCE OF POWER UNITS IN BILIBINO ATOMIC HEAT AND POWER STATION WITH AUTOMATIC POWER AND FREQUENCY REGULATION IN ISOLATED POWER SYSTEM

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 28 May 80) pp 147-150

SANKOVSKIY, G. A., MOLOCHKOV, V. I., DULGOV, V. V., SOLDATOV, G. Ye. and MINASHIN, M. Ye.

[Abstract] An experimental study was made of four similar power units in the Bilibino atomic heat and power station operating with automatic power and frequency regulation in the isolated Chaun-Bilibino power system. Each power unit consists of a water-graphite channel reactor with tubular fuel elements and natural circulation of boiling water, and a turbine-generator set with two outlets for central heating. The turbines run on dry saturated steam with intermediate separation. The transient responses of performance parameters to frequency excursions and to load changes were measured, while two modes of automatic power and frequency regulation were tested: 1) primary static regulation of frequency through speed regulator at the turbine with the switch open followed by secondary regulation of frequency and electric power on the network side with the switch closed; 2) through action of regulators of frequency and electric power on regulator of neutron power and action of reactor pressure regulator on speed regulator at the turbine with the switch closed. Both modes were found to be satisfactory for reliable heat transfer from the core during transient processes and programmed load variations, the first mode

providing better protection of the reactor against external essentially momentary perturbations in the power system. Figures 4, references 3 Russian.
[49-2415]

UDC 621.039.566.6

OPTIMIZATION OF COMPOSITION OF MAKEUP FUEL FOR WATER-MODERATED WATER-COOLED POWER REACTOR

Moscow ATOMNAYA ENERGIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 23 Sep 80) pp 161-163

PAVLOV, V. I., PECHIKIN, V. A., POBEDIN, V. V. and SIMONOV, V. D.

[Abstract] A characteristic feature of the fuel cycle for a water-moderated water-cooled power reactor is an annual calculated partial recharging by replacement of the most depleted fuel assemblies with fresh ones. Formation of a core that will ensure reliable heat transfer and will hold for a specified operating period requires successive changes in the fuel composition. The problem is one of first detecting the most depleted assemblies and configuring the core for most nearly uniform energy distribution, and then designing the control of the internal reactor fuel cycle. Here the first part of the problem is formulated as an optimization problem, namely finding the minimum-cost composition of fresh fuel to ensure reactor operation at the nominal power level for the specified period of time. The problem can be solved on a BESM-6 high-speed computer, using the OSOT and BIPR programs. It has been solved by this method for the fuel cycle in a VVER-440 water-moderated water-cooled power reactor. Table 1, references 6: 5 Russian, 1 Western.

[49-2415]

NON-NUCLEAR ENERGY

UDC 621.311.22.002.72

HEAD POWER UNIT OF 1200 MW AT KOSTROMSKAYA STATE REGIONAL ELECTRIC POWER PLANT

Moscow ELEKTRICHESKIYE STANTSII in Russian No 9, Sep 81 pp 2-7

ZUBOV, I. V., engineer, VOLKOV, B. A., engineer, BOGACHKO, Yu. N., engineer, CHUDOV, B. V., engineer, and KULIKOV, Yu. P., engineer, Kostromskaya State Regional Electric Power Plant

[Abstract] The head power unit at the Kostomskaya state regional electric power plant has an installed capacity of 1200 MW consisting of a K-1200-240-3 turbine with TVV-1200-2UZ generator built at the Leningrad Metal Works and TGMP-1200 boiler with superheater and supercharger built at the Taganrog "Krasnyy Kotel'nik" Plant. The boiler has single-shell construction, the furnace chamber is an open prismatic one. Heating is effected by convection and radiation. Integrally welded-on radiative shields are divided heightwise into lower, central and upper sections. Convective heat exchangers include low-pressure tubing and economizer tubing. There are 56 hybrid gas-oil burners, as well as a preheater and regenerator. The gas-air system can operate with forced draft, with the aid of exhaust fans, or with induced draft. The turbine consists of five cylinder stages (one high-pressure, one medium-pressure, three low-pressure) on a single shaft, with six steam exhausts and two longitudinal condensers. It operates at a nominal speed of 3000 rpm using fresh steam (240 kgf/cm^2 , 540°C) at a nominal rate of 3660 t/h. Cooling water at 12°C is supplied at a rate of $105,000 \text{ m}^3/\text{h}$. The electric generator consists of a segmental stator made of 0.5 mm gauge laminated transformer steel with two 3-phase windings in parallel and shifted by 30°el . to form a 6-phase system, using hydrogen-cooled hollow conductors, and a solid rotor made of special-grade steel with winding of silver-bearing copper ribbon. The generator delivers nominally 1200 MW at 98.8% efficiency, at 24 kV and 50 Hz, with 11% overload capacity. Power to the network is distributed through three single-phase step-up transformers at 500 kV. Station auxiliaries are supplied through two step-down transformers at 1 kV and 400 V respectively, consuming only 1.4% of the generated energy. The operation of the entire power unit is automatically controlled. The power unit operates 6000 h/yr with average fuel economy of 0.313 kg/kWh. The material content of its structure is 8.4 t/MW metal, 0.091 t/MW reinforced concrete and $13 \text{ m}^3/\text{MW}$ thermal insulation. Figures 4, tables 3.

[60-2415]

UDC 621.224-783.56

HYDRO POWER EQUIPMENT OF SAYANO-SHUSHENSKAYA HYDROELECTRIC POWER PLANT

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 8, Aug 81 pp 12-18

CAMUS, I. M., engineer

[Abstract] The hydro power equipment for the Sayano-Shushenskaya hydroelectric power plant has been built jointly by the Leningrad branch of "Gidroproyekt", the association of Leningrad Metal Works, the Leningrad electrotechnical industrial association "Elektrosila" imeni S. M. Kirov, the industrial association "Zhdanovtyazhmash", and the special engineering office of "Lengidrostal". The equipment was designed for capacity of 6400 MW at nominal power head of 194 m, average operating head of 200 m, head fluctuation over the 175-220 m range, and minimum starting head of 60 m. The equipment includes 10 R0-230/833-677 radial-axial turbines operating at nominal speed of 142.8 rpm and optimum efficiency of 95.8%, each having 13% overload capacity, with SFV 1285/275-42U4 umbrella-type generators. These generators, unlike conventional ones, have an integral stator structure completely assembled each directly in its own foundation pit. The stators have hollow conductors with water cooling. The rotors have forced air cooling, the exciter mounted on the main shaft, and piston-type pneumatic brakes for shutdown. The rotors are mounted in special double-row segmental self-lubricating thrust bearings. Water at a regulated rate up to 1900 m³/h is fed separately to each turbine-generator set through two ejectors. The water feed and oil feed systems as well as inspection and measuring equipment are conventional. The operation of all components is automated by the latest non-contact control devices and a computer.

Figures 4, tables 2.

[52-2415]

UDC 621.472:628.18.633.213

COST EFFECTIVENESS OF SOLAR POWER PLANT FOR PUMPING UP WATER UNDER CONDITIONS IN UZBEKISTAN

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 30 Mar 81) pp 62-63

ZAKHIDOV, R. A. and BOGDASAROV, V. M., Central Design Engineering Office for Scientific Instruments, UzSSR Academy of Sciences

[Abstract] A solar power plant has been developed at the Physico-Technical Institute and the Central Design Engineering Office for Scientific Instruments (UzSSR Academy of Sciences) for pumping up water in regions of Uzbekistan far removed from electric transmission trunklines. The energy source in this ASEU-0.5 plant is a dynamic converter operating with the Stirling cycle. Here its cost effectiveness is evaluated on the basis of minimum equipment and

operation costs over depreciation periods appropriate for the various plant components. Its cost effectiveness is found to be better than that of a plant with a photoelectric converter, with the cost of water lifting reduced to only 0.09 rubles/m³ but with a warranty period 1.7 times shorter. Table 1, references 4 Russian.

[48-2415]

L. : 621.472

METHOD OF DESIGNING LOW-TEMPERATURE SOLAR HEATERS WITH DIURNAL UNSTEADINESS OF INTERNAL THERMAL PROCESSES TAKEN INTO ACCOUNT

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 15 Aug 80) pp 53-58

BATMUNKH, S., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences, and AVEZOV, R. R., "Order of Labor's Red Banner" Mongolian State University, Ulan-Bator

[Abstract] A calculation procedure based on mathematical simulation is shown for optimum design of solar-power air and water heaters which takes into account diurnal periodicity and inertia of internal heat and mass transfer processes. The equations of heat balance are formulated separately for each heater component, a thermoreceiver made of two shaped steel strips and a 2-layer cover plate. The thermal capacity and absorptance of air pockets between steel and glass are disregarded, as are also temperature drop across the thickness of glass and circumferential temperature gradient in heat transfer channels. Uniform distribution of coolant between thermoreceiver channels and one-dimensional thermal flux through bottom insulation are assumed, with heat transfer occurring in accordance with Newton's law. Computer calculations for a 2.5 m long and 1.08 m wide thermoreceiver agree fairly closely with experimental data and thus validate this mathematical model. Figures 2, references 3 Russian.

[48-2415]

PRODUCTION AND PROPERTIES OF PHOTOELECTRIC CONVERTERS BASED ON EPITAXIAL SILICON STRUCTURES

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 6 May 81) pp 33-38

SAIDOV, M. S., ABDURAKHMANOV, B. M., ALIYEV, R. and CHIRVA, V. P.,
Institute of Electronics imeni U. A. Arifov, UzSSR Academy of Sciences

[Abstract] A study was made to determine the feasibility of reprocessing single-layer epitaxial silicon structures rejected by quality control for subsequent use in photoelectric converters. Such reprocessing must result in lower defect density and lesser defect localization at the same time, which calls for heat treatment with a strongly doped epitaxial layer serving as the diffusion source and for partial or full chemico-mechanical removal of the epitaxial layer. Substrates with p⁺-n or n⁺-p structures or epitaxial layers with n-n⁺ or p-p⁺ structures are best suitable as base regions of photoelectric converters. Experimental devices were thus produced from such substrates of grades KEF-20 and KDB-10 material 40-60 mm thick as well as from 48-72 μm thick epitaxial layers, strongly doped from BBr₃ and PCl₃. Their current-voltage characteristics in darkness and in light as well as their spectral characteristics at various temperatures were measured, also the dependence of their performance characteristics (no-load voltage, current density, efficiency, fill factor) on temperature over the -150 to +150°C range and on the luminous flux density over the 0-0.8 W/cm² range. The results indicate that unconditioned epitaxial silicon structures are usable as raw material for photoelectric converters. Figures 6, references 8 Russian.

[48-2415]

CONSTRUCTION

UDC 69.059.22:624.132

CAUSES OF FOUNDATION FRACTURE UNDER PERMAFROST SOIL CONDITIONS AND PREVENTIVE MEASURES

Moscow OSNOVANIYA, FUNDAMENTY I MEKHANIKA GRUNTOV in Russian No 5, Sep-Oct 81 pp 13-15

POLUEKTOV, V. Ye., candidate of technical sciences, MEZHENSKIY, V. I., engineer, and RUMYANTSEV, S. F., engineer, Noril'sk branch, Krasnoyarsk Scientific Research Institute of Industrial Construction Planning

[Abstract] Frequent fractures of concrete and reinforced-concrete foundations under buildings and cold cellars have recently occurred in the Noril'sk district, mainly due to seasonal freezing-thawing cycles and capillary action or due to shear cracking of pillars. A regression analysis of experimental data pertaining to foundation pillars respectively 4-7 years and 8-13 years in service reveals that the moisture content reaches its maximum of 6-8% between 1.2 m below and 0.25 m above ground level, which correlates with temperature variations, and that the mechanical strength is correspondingly minimum at approximately the same depth. On the basis of the results of this study, empirical relations have been established for adjustment of the concrete mix, especially the gravel content, so as to ensure adequate mechanical strength and durability in accordance with standard requirements. Figures 2.
[61-2415]

INDUSTRIAL TECHNOLOGY

ELECTROMAGNETIC BOLT AND WASHER MATCHING DEVICE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Sep 81 p 2

[Text] Riga--Bolts and washers are being matched at record speed by an automatic device developed by designers at the Physics Institute of the Latvian Academy of Sciences. Its productivity, 180 sets per minute, is more than double that of similar automatic devices. Operating time was able to be reduced sharply through use of a magnetic field, which matches threaded bolts and washers with a high degree of accuracy. The new device can be easily adjusted, depending upon the type and size of the fastenings. It will find wide application at tool and machine building enterprises, where it can effect considerable savings.

9643
CSO: 1861/53

UDC 621.7-1-113

MAIN TRENDS IN IMPROVEMENTS OF MACHINING TECHNOLOGY FOR PARTS OF WATER TURBINE EQUIPMENT

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 81 pp 13-14

CHIRKOV, M. A., engineer

[Abstract] The latest achievements in power generating equipment include 700-750 MW turbogenerators of the adjustable-vane type in the Saratovskaya hydroelectric power plant, of the diagonal type in the Zeyskaya hydroelectric power plant, and of the radial-axial type in the Ust'-Ilinskaya, Sayano-Shushenskaya, Nureskaya and Ingurskaya hydroelectric power plants. These achievements are made possible by improvements in the manufacturing technology, machining and surface finishing of parts, which ensure a high resistance to cavitation. The new technology developed at the All-Union Planning and Technological Institute of Power Equipment Manufacture includes special-purpose tools in universal machines operating with digital programmed control. As many operations as possible, including grinding, are combined in one stand. The higher precision of these operations results in better quality of products, on-line measurements and inspection ensure lower reject rate, and there is also a saving in labor. This technology is being further improved where necessary, there is a need for better fabrication and heat treatment of castings and forgings as well.

[68-2415]

UDC 658.011.56:007.52

AUTOMATIC COMPLEX INCLUDING TWO ROBOTS

Moscow MASHINOSTROITEL' in Russian No 9, Sep 81 p 14

ZHURAVLEV, V. A., PASHKOV, V. V. and LUKIN, V. I.

[Abstract] At the Zhdanov branch of the Design Engineering and Technological Institute of Soil Cultivation Machinery an automatic complex of equipment has

been developed for production of weeder claws. It includes two industrial robots with mechanical forming and heat treatment apparatus: a loader, a damper furnace, a high-frequency electric heater, a quench tank, a K18002 press and a die for prong bending, a K18004 press and a die for hole punching, an unloader, two cabinets, a programmable jet-flow cycle control, two VChI3-160/0.066 high-frequency vacuum-tube oscillators and two load circuits. During startup and adjustments as well as during repairs the complex can be controlled manually from a panel. This complex, when installed at the Odessa Agricultural Machinery Plant should yield an annual saving of 47,000 rubles in production costs.

[54-2415]

UDC 621.315.62

SCIENTIFIC-TECHNICAL PROGRESS IN INSULATOR-AND-FIXTURE PRODUCTION

Moscow ENERGETICHESKOYE STROITEL'STVO in Russian No 8, Aug 81 pp 36-38

DUBOV, I. V., engineer

[Abstract] For production of insulators and fixtures for high-voltage power equipment for the 1990-2000 period, the USSR Ministry of Energy, in conformance with resolutions of the 26th CPSU Congress, plans to ensure the necessary supply of basic materials such as porcelain and copper-clad rolled aluminum. The basic technologies exist already and implementation of mechanized-semiautomated manufacturing processes is to proceed in three stages: 1) welding of lugs, 2) clamp assembly with elimination of drilling, 3) chemical cleaning of contacts. Included will be, furthermore, the necessary forming operations as well as product quality control through inspection and testing. As a model can serve the "Erfurt" production line almost complete for operation in the GDR. The recycling program should cost roughly 30 million rubles and result in an annual saving of 250.69 million rubles to the industry, relieving 2000 persons (including 1350 women) from manual labor. Approximately 4.9 of the 30 million rubles is earmarked for scientific and engineering activities.

[52-2415]

UDC 621.313.13

USING LINEAR MOTORS IN AUTOMATIC MANIPULATORS

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 8, Aug 81 pp 5-6

BLAZHKO, Yu. M., candidate of technical sciences, and OKHRIMENKO, V. N., engineer

[Abstract] The authors discuss the feasibility of using linear induction motors for developing automatic manipulators with reciprocating motion of the

actuating element. Among the main advantages of linear induction motors over mechanical devices for converting rotational motion to translational motion, and devices based on pneumatic and hydraulic drives, are direct linear displacement of the actuating element without intermediate links, good starting characteristics, relatively simple solution of problems involving reversal or deceleration of a secondary element, high linear velocities and accelerations, and practically unlimited displacement of the secondary element.

Research by the Ukrainian Polytechnical Correspondence Institute has shown the following disadvantages of existing designs of cylindrical linear induction motors for mechanization of technological processes: the motor runner is copper-coated and is held in the stator on bronze or brass plain bearings (sleeves), leading to rapid wear because of the poor antifriction properties of the copper-brass friction couple; displacement of the axes of runner and stator leads to considerable radial forces that also increase wear, resulting in failure of the motor; no cooling systems have been developed for repetitive short-term operation. A design is suggested in which roller bearings replace the plain bearings, and provisions are made for adjusting the position of the runner axis relative to the stator axis during operation. A forced cooling system is proposed with the stator housing placed in a cylindrical jacket; the coolant (air or water) flows in the space between the stator housing and the jacket. Experimental models of these motors are now being tested in industry. Laboratory and factory tests have shown them to be workable and reliable. Figures 2.

[59-6610]

UDC 621.73.077

PROGRAM MODULE FOR TSIKLON-3B MANIPULATOR

Moscow MEKHANIZATSIIA I AVTOMATIZATSIIA PROIZVODSTVA in Russian No 8,
Aug 81 pp 9-10

FOMIN, A. V., AGAFONOV, Yu. T., BABUSHKIN, A. A. and OKHOTNIKOV, A. N.,
engineers

[Abstract] The program module of the Tsiklon-3B automatic manipulator is a panel on which plugs, microswitches and toggle switches are used to set up the operating program of the manipulator and electromechanical step switch. Work experience has proven this program module to be unreliable. Malfunctions arise due to loss of contact in the panel and step switch, failures of step switch operation or "skipping" of contacts. In addition, the step switch has a long operating time (about 0.2 s), and when being reset it passes over wafers that are not used in the program, which increases the cycling time for making an item and reduces the productivity of the facility. Because of the large number of contacts, preventive maintenance is tedious and complicated. To eliminate these flaws, a non-contact program module has been developed that consists of an electronic commutator and a diode matrix (program store). The electronic commutator is made with series K155 integrated circuits and switches actuating

relays in the manipulator control panel via the diode matrix. The device controls 16 program steps. Diode matrix boards can be easily changed when a new program is required. Use of the new program module improves reliability and shortens the working cycle. As an example, the new system has shortened the time for making forgings on a hot stamping line from 13 s to 10 s.

Figures 2.

[59-6610]

UDC 681.51:007.5

PHOTOELECTRONIC SYSTEM FOR RECOGNIZING MOVING ITEMS

Moscow MEKHANIZATSIIA I AVTOMATIZATSIIA PROIZVODSTVA in Russian No 8, Aug 81
pp 11-12

MESHCHERYAKOV, A. Yu., engineer

[Abstract] A system is described for recognizing moving items on overhead conveyers for interfacing automatic manipulators with the ambient on automatic transfer lines. The basic elements of the system are a light pulse source, photosensor, primary data processor, recognition unit and classifier. The source of optical emission is a gas-discharge flashlamp that produces light pulses with initial luminous energy of 100 cd·s, and duration of 10^{-4} s at recurrence rates from 0.1 to 10.0 Hz. The photosensor is a straightedge with uniformly spaced photocells to receive luminous information and produce electric signals. The straightedge is placed vertically and is long enough to cover the maximum height of the image of items projected by the light source. At the instant of the flash, a signal appears at the photosensor output that is an approximation of a fragment of the item to be recognized. The primary processing unit samples these signals at the pulse recurrence rate of the light source, giving instantaneous cross sections of the item in the plane perpendicular to the plane of suspension and passing through the photosensor. The number of samples depends on the flash frequency and rate of motion. The primary processor converts the set of signals arriving simultaneously from the photodiodes to a combination of symbols taking values of 1 (above a certain threshold) or zero. In addition, the primary processor calculates the dimensions of lighted and shaded parts of the fragment of the item. The unit also marks the instant when all cells of the photosensor are illuminated, i.e. when the item has moved out of the field of view. The recognition device determines characteristic features of the moving item. The classifier operates on a special coding system, and has as many channels as there are items to be recognized. Extra channels are provided for expanding the range of items, and the classifier can "learn" new classes without adjustment. Figures 3.

[59-6610]

CONDITIONS FOR INTRODUCING AUTOMATIC MANIPULATORS IN MACHINE BUILDING

Moscow MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian No 8, Aug 81
p 20

ZHELTOVSKIY, G. A., department chairman, Pavlodar Industrial Institute

[Abstract] This article is part of a commentary on a paper by V. P. Bobrov: "Conditions for Introducing Automatic Manipulators in Machine Building", MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA, No 4, 1981. The author urges the editors of this magazine to open a discussion on the issue, after which it will be possible to arrive at a consensus regarding the conditions. It is argued that one of the major conditions for successful introduction of automatic manipulators is division of the procedure into two processes: 1. development and series production of automatic manipulators designed around the modular principle, enabling a wide range of adaptability to each specific case; 2. development and series production of robotized work centers with components matched in design. Economic and cost factors are considered. Further suggestions of conditions that must be met for introducing automatic manipulators in machine building include: organization of specialized research, design and industrial agencies; setting up divisions in industrial enterprises to handle technical and economic preparation for wide-scale introduction of automatic manipulators; introduction of manipulators and robotized centers in economically justified groups; training a sufficient number of specialists in all skill levels.

[59-6610]

PERMANENT ROTATIONS OF HEAVY SOLID ON ABSOLUTELY ROUGH HORIZONTAL PLANE

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 5,
Sep-Oct 81 (manuscript received 20 Oct 80) pp 808-814

KARAPETYAN, A. V., Moscow

[Abstract] An analysis is made of the problem of permanent rotations of a heavy solid bounded by a convex surface and located on an absolutely rough horizontal plane. The position of the solid is assigned by the coordinates x and y of its center of mass in stationary coordinate system Oxyz, where plane Oxy coincides with the supporting plane, axis Oz is directed vertically upward, and by the Euler angles θ , ϕ and ψ made by the principal central axes of inertia G_x , G_y and G_z of the solid with the axes of the stationary coordinate system. Conditions of existence and stability of permanent rotations are derived for the problem. The author discusses the similarities and differences between the given problem and the problems of permanent rotations of a solid

on an absolutely smooth plane, and of a solid with a stationary point. In the case of an absolutely rough plane, asymptotic stability with respect to some of the variables is possible even though the system is conservative. In this case, stability depends on the sense of the rotation. References 7 Russian.
[63-6610]

UDC 681.513.1:007.52-52

MODULAR MANIPULATOR CONTROL SYSTEMS

Moscow MASHINOSTROITEL' in Russian No 8, Aug 81 pp 41-43

PANOV, A. A., candidate of technical sciences, chairman of the Industrial Robots and Manipulators Commission of the Committee on Automation and Mechanization, All-Union Council of Scientific and Technical Societies

[Abstract] An examination is made of the use of modular design to improve flexibility and efficiency of systems for controlling industrial robots in short-series production. The article is based on a review of non-Soviet publications. Requirements for using microprocessors are considered, and a block diagram is given of a modular multiprocessor control system in which the central processor is supplemented by two additional processors that realize interpolation algorithms, and process signals that characterize the control process. The modular structure in such systems applies to the software as well. The designs and functions of different kinds of modules are briefly described. Figures 3.

[66-6610]

TURBINE AND ENGINE DESIGN

UDC 621.313.322-81.012.6

ESTIMATING VARIANCE IN DYNAMIC CHARACTERISTICS OF TURBINES OF SAME TYPE

Moscow ELEKTRICHESKIYE STANTSII in Russian No 10, Oct 81 pp 26-29

IVANOV, V. A., doctor of technical sciences, Leningrad Polytechnic Institute,
RUDNITSKIY, G. M., engineer, Khar'kov Turbine Plant

[Abstract] Torque control of turbines for fast unloading of electrical transmission lines improves the stability of parallel operation of power systems, but can be effective only when taking into account the variance in the dynamic characteristics of turbines in the systems. Estimates of this variance were made for K-300-240 turbines manufactured at the Khar'kov Turbine Generator Works. Calculations were based on differences in the responses to regulator signals and between the turbine-regenerator steam channels, characteristics of the steam generators assumed to be playing no role during short transients. Load dumping by pulse action was considered, unloading depth (torque decrement) and time being the principal parameters here. The probabilistic model for both parameters as functions of the signal duration was constructed assuming, on the basis of physical concepts, normal distributions of the random variables. The mathematical expectations and the variances as well as the confidence intervals were determined accordingly. The results of this analysis indicate that for this particular type of turbines the torque decrement in response to identical control signals will, with a statistical accuracy of 99%, vary not more than within +7% of the nominal torque. The validity of this mathematical model has been confirmed by field tests.

[65-2415]

UDC 621.311.22:621.165:621.176.2.004.12

USING JET PUMPS IN OPTIMIZED WATER CIRCULATION SYSTEMS FOR TURBOGENERATOR SETS

Moscow ELEKTRICHESKIYE STANTSII in Russian No 10, Oct 81 pp 23-26

KAYUKOV, S. I., engineer, MOKROUSOV, V. A., engineer, IVANOV, V. A., engineer, and SIMONOV, V. Ya., engineer, Ural Power Engineering Administration, Reftinskaya State Regional Electric Power Plant

[Abstract] Maintenance of the optimum vacuum in turbine condensers during seasonal fluctuations of the feedwater temperature or variations of the electrical load requires boosting the circulation of water for cooling the lubrication system and in other heat exchangers. In the Reftinskaya state regional electric power plant a costly redesign of the circulatory cooling system has been avoided by installing jet pumps as auxiliary flow boosters. The performance characteristics of jet pumps are more adequate for this requirement than are those of centrifugal pumps, the latter also being more difficult to install and requiring a standby capacity. Their performance in all six 300 MW turbogenerator sets was tested and found to be satisfactory, contributing to the economy of plant operation a saving of approximately 54,000 rubles annually. Figures 5, references 7 Russian.

[65-2415]

UDC 621.431.3-71.001.24

IMPROVEMENT OF HIGH-TEMPERATURE DIESEL COOLING SYSTEMS

Leningrad DVIGATELESTROYENIYE in Russian No 4, Apr 81
(manuscript received 12 Nov 80) pp 30-34

KRIVOV, V. G., doctor of technical sciences, professor, distinguished scientist and engineer of the RSFSR, SINATOV, S. A., candidate of technical sciences, KABYSH, V. V., candidate of technical sciences, and AVER'YANOV, V. K., candidate of technical sciences, lecturer, Leningrad Air Force Structural Engineering Academy imeni A. N. Komarovskiy (General of the Army)

[Abstract] High-temperature cooling of ship and land diesel engines has been found to result in more economical and stable performance under partial loads, while allowing for greater flexibility over the entire load range, and reduced corrosive wear owing to more steady and uniform temperature distribution. It furthermore requires smaller and less costly heat exchangers with simpler and faster temperature regulation. There are, however, some problems in the design and operation of heat exchangers and circulation pumps with cooling water allowed to rise to 366-373 K and even higher on the outlet side. Here the performance of a circulation pump and the changeover from conventional 2-loop diesel cooling with a water-water refrigerator to open high-temperature diesel cooling through disconnection of the auxiliary heat pump and connection

of a steam separator are analyzed on the basis of the Bernoulli equation for the water-steam system and the Rudnev equation for the critical cavitation margin, also using the known head-flow curves. An improvement of the high-temperature cooling scheme is proposed, on the basis of this analysis, which includes a mixer-backwater stage and a bypass for reduction of hydraulic losses and ensuring low cavitation level. Figures 4, references 9 Russian.
[58-2415]

UDC 621.43-233.2.001.57

ANALYSIS OF VISCOUS-FRICTION BEARING DESIGN AND PERFORMANCE PARAMETERS BY METHODS OF PLANNED COMPUTER EXPERIMENT

Leningrad DVIGATELESTROYENYE in Russian No 4, Apr 81
(manuscript received 21 May 80) pp 26-27

KONDRATYUK, S. V., candidate of technical sciences, and KONDRATYUK, V. V., candidate of technical sciences

[Abstract] A complete hydrodynamic design and performance analysis of main, connecting rod, supercharge compressor and other bearings by conventional methods is becoming more difficult because of the increasingly sophisticated nonlinear differential equations included to properly describe the effects of viscous and inertia forces. Proposed as a remedy is a 2^n -factorial computer experiment according to the central orthogonal plan, this plan having been found to be more efficient than some other plans. The scheme is demonstrated on a 2-level 4-factor plan for design and performance analysis of a typical sliding bearing 0.3 m long and 0.055 m in diameter with a radial clearance of 160 μm for a nominal speed of 1675 rad/s under a load of 2.6 kN, with the lubricant temperature at the inlet remaining within 20-40°C. The experiment has been programmed in FORTRAN-4 on a YeS-1022 Unified System computer. It has produced regression equations for the mean bearing temperature, average friction power loss, average lubricant flow rate, and minimum thickness as well as maximum load carrying capacity of the lubricant film. Included are estimates of the dispersion coefficients. On the basis of these equations, it is possible to evaluate the effect of each factor individually. Should any model be inadequate, it is possible to repeat the experiment with a narrower range of factor variation or with a different center point between two levels or after transformation of variables. Tables 1, references 1 Russian.

[58-2415]

UDC 621.436-752.001.24

CALCULATING AND METHODS OF REDUCING VIBRATIONS OF COMPONENTS OF MEDIUM-POWER DIESEL ENGINE BLOCKS

Leningrad DVIGATELESTROYENIYE in Russian No 4, Apr 81
(manuscript received 15 Sep 80) pp 23-26

YANCHELENKO, V. A., candidate of technical sciences, Central Scientific Research Institute of Diesel Engines

[Abstract] Vibrations of structural components of diesel engine blocks have been calculated according to a model in which each component is a statically independent source of vibration energy, the energy flux becoming only attenuated or amplified and delayed but not distorted as it propagates from any one source to a flange at which it is measured. An experimental study was made, furthermore, confirming the diffusive character of the principally flexural vibrations. An evaluation of the velocity-acceleration and power spectra by third-octave bands extending above the 63-4000 Hz range, measured on DG-50 and Dg-100 diesel-generators mounted respectively on 6Ch12/14 and 6Ch15/18 diesel pans, indicates the most effective ways to reduce vibrations. These are increasing the mechanical coupling impedance between pan and block through insertion of elastic spacers or coating of metal surfaces with a damper material so as to eliminate critical metal-to-metal contacts and decreasing the vibration velocity through substitution of a highly damping copper-manganese alloy for an aluminum alloy or cast iron or steel as the material of frame parts. Figures 6, references 15: 12 Russian, 3 Western.

[58-2415]

UDC 621.431.72/74.001.2

PROBLEMS IN CONFIGURATION OF DIESELS WITH 2-STAGE TURBOSUPERCHARGE SYSTEMS

Leningrad DVIGATELESTROYENIYE in Russian No 4, Apr 81
(manuscript received 27 Mar 80) pp 3-8

NIKITIN, Ye. A., candidate of technical sciences, and MEDEN, A. I., candidate of technical sciences, Boiler and Turbine Plant imeni V. V. Kuybyshev

[Abstract] Turbosupercharging of diesel engines is considered as a means of decreasing the weight-to-power ratio, 2-stage supercharging by means of centrifugal compressors being most effective where very high pressures are involved. On the basis of the standard relation between air flow rate in a diesel and the diesel geometry, a relation is established which indicates how the required diameter of the compressor runner depends on the size of diesel cylinders and on the degree of supercharge. Numerical data are given for 2-stage superchargers with either end cooling of air only or with both intermediate and end cooling of air, these data being compared with those for

single-stage superchargers with end cooling or without cooling of air. Several configurations are shown, their main design and performance features are compared, including those of an inline engine and a V-engine as well as a spider engine with supercharge ratios ranging from 4 to 10 and with correspondingly increasing complexity. Figures 7, table 1, references 6: 2 Russian, 4 Western.

[58-2415]

UDC 621.165.001

EXTREME OPERATING MODES OF CENTRIFUGAL TURBINE STAGES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 7, Jul 81 (manuscript received 17 Mar 80) pp 114-117

BIRZHAKOV, M. B., candidate of technical sciences, LITINETSKIY, V. V., candidate of technical sciences, and BERMAN, B. I., engineer, Chair of Turbine Design, "Order of Lenin" Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] The performance of a centrifugal turbine stage under far from optimum operating conditions, namely during transition to or from the compressor mode of operation, is analyzed on the basis of simple thermodynamic and hydrodynamic relations. The critical specific circumferential velocity corresponding to turbine-to-compressor transition of a stage with given radiality index is determined from dimensionless flow characteristics, typically for a speed of 16,600 rpm and pressure ratio of 0.932 (expansion) respectively. Such a transition and the reverse transition are found to occur without hysteresis and without discontinuities. Figures 2, table 1, references 1 Russian.

[50-2415]

UDC 621.165:438

TANGENTIAL TILTING OF NOZZLE BLADES FOR MORE ECONOMICAL OPERATION OF TURBINE STAGES WITH UNTWISTED BLADES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 7, Jul 81 (manuscript received 15 Dec 80) pp 111-114

KORZUNOV, Yu. L., engineer, and MITYUSHKIN, Yu. I., candidate of technical sciences, docent, Chair of Ship Turbines and Turbine Plants, "Order of Lenin" Leningrad Shipbuilding Institute

[Abstract] An experimental study was made of 20 untwisted nozzle blades with various angles of tangential tilt, for operation in subsonic turbine stages, to determine the effect of tangential tilting on the reactivity index of a

stage and on turbine operation economy. In all combinations of five nozzles and four different types of active cascades the mean diameter was 360 mm, the blade length was 60 mm and the radial clearance above an unbanded blade was 1.0 mm. The tangential tilt of blades was varied from 0 to 30°, tests were performed with the gas velocity at the nozzle exit within 0.52-0.60 Mach and the Reynolds number within $(4.8-7.0) \cdot 10^5$. The results indicate that as tangential tilt is increased, the reactivity index increases to saturation at about 20° and hardly increases further, while the longitudinal gradient of the reactivity index decreases to zero at 5-15°, depending on the type of cascade, and increases in the negative direction. While some tangential tilting is found to improve turbine operation economy, excessive tilting is not advisable. Figures 2, table 1, references 5 Russian.

[50-2415]

WORK EXPERIENCE OF SEMINAR ON PROBLEMS OF DEVELOPING MARINE TURBINE FACILITIES

Leningrad SUDOSTROYENIYE in Russian No 10, Oct 81 pp 27-28

KURZON, A. G.

[Abstract] The author gives a summary of work done by the Seminar on Problems of Developing Marine Turbine Facilities organized by the turbine section of the Central Board of the Scientific and Technical Society imeni A. N. Krylov in cooperation with the marine power plant department of Leningrad Shipbuilding Institute. This seminar has been in continuous operation since 1974. The work of this group covers problems of designing, calculating and testing turbines and turbine units of all types (steam, gas, combination) and auxiliary equipment, boilers, mechanisms, heat exchangers and so on. Seminar reports are in two categories: "Development of Marine Turbine Facilities and New Design Methods" and "Thermophysical Problems of Improving Components of Marine Turbine Facilities". About 100 papers have been delivered in 50 classes over the period from 1974 to 1980 with 60% in the first category and 40% in the second. The best papers are published in collections for exchange of experience. Most classes are attended by 30-60 persons, although there may be only 10-15 present for certain special problems of the second category, and the audience may swell to 100-150 for papers on generalizing problems of the first category. Guest speakers have included professors M. Ye. Deych, K. G. Kostyuk, B. M. Troyanovskiy and O. M. Yemin. A plenary session on 14 April 1981 dealt with the design and use of combination gas-steam turbine facilities on the first three Kapitan Smirnov ships. Fuel and oil consumption on such ships are comparable with medium-rpm diesel ships. It is predicted that combination turbine facilities may achieve fuel economy of 204 g/kWh or better in the Eleventh Five-Year Plan. Plans for 1981 and early 1982 call for 15 classes with discussion of 18 reports in the first category and 20 in the second. The seminar is now dealing with fuel problems, including the use of coal in marine turbine facilities, and a special conference on the fuel problem is to be held in 1982.

[67-6610]

NAVIGATION AND GUIDANCE SYSTEMS

UDC 531.8

USE OF VISUAL INFORMATION FOR CONTROL OF WALKING MACHINES

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 81 (manuscript received 26 Sep 79) pp 36-46

BORDYUG, B. A. and LARIN, V. B., Kiev

[Abstract] Use of visual information at the lower level (equation of dynamics) in the hierarchical structure of control for a walking machine is considered, namely in stabilization of horizontal and vertical motion on each step. Horizontal stabilization involves step-by-step tracking of the path from a given reference point. Vertical stabilization involves control with anticipation of obstacles causing perturbations. Both problems are treated as linear-quadratic Gaussian ones and reduced to a Riccati $n \times n$ matrix equation with a periodic solution. Possible minimization of the leg force during motion on an uneven surface is treated as a problem of overcoming obstacles and is solved by mathematical simulation on a computer. The trajectories and the stabilization performance have been calculated thus for a two-legged walking machine with typical parameters. Figure 1, table 1, references 9: 8 Russian, 1 Western.
[93-2415]

UDC 531.55:521.1

CORRECTION OF INERTIAL NAVIGATION SYSTEMS WITH AID OF COMBINED VELOCITY AND SUPPLEMENTARY POSITION DATA

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 81 (manuscript received 9 Oct 79) pp 12-19

KALENOVA, V. I., MOROZOV, V. M., PARUSNIKOV, N. A. and SHAKOT'KO, A. G.,
Moscow

[Abstract] The authors propose a technique for correcting inertial navigation systems by using combined velocity data and supplementary position data. For illustration, this method is applied to a linear system $d\xi/dt = G\xi + q$,

$\dot{\xi} = G\xi + r$ (ξ is the n -dimensional state vector, σ is the s -dimensional measurement vector, G and H are constant matrices of corresponding dimensionalities, q and r are random vector processes of the "white noise" kind with known intensities). An estimation algorithm is constructed which includes decomposition of the problem into components of the measurement vector and thus into several subproblems with scalar measurements. This algorithm is found to be generally a 2-step one. Here it is modified conveniently for use of combined data in the specific case of aircraft navigation, where the object moves at a velocity much lower than orbital velocity and evolves to a limited altitude.

References 6: 5 Russian, 1 Western.

[93-2415]

UDC 531.55:521.1

SEPARATION OF MOTION COMPONENTS IN FLIGHT DYNAMICS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 81 (manuscript received 24 Apr 80) pp 3-11

BORZOV, V. I., Moscow

[Abstract] The motion of an aircraft relative to Earth is analyzed in a classical system of coordinates, considering that the center of mass is driven by the engine thrust as well as by gravity and three aerodynamic forces (drag, lift, lateral). The motion of an aircraft is known to involve two components: fast rotations about the center of mass with short time constants of the order of seconds and slow translations of the center of mass with time constants of the order of minutes. Here the differential equations for each component separately are derived from the fundamental system of equations by the method of a small parameter. With the ratio of the respective time constants as the small parameter, the kinematic equations degenerate to dynamic equations describing the long-period motion of the center of mass with regular perturbations. The dynamic equations describing the short-period motion about the center of mass with singular perturbations are then obtained by an asymptotic method. References 7 Russian.

[93-2415]

DRIFTS OF 2-GYRO DEVICES DURING ANGULAR OSCILLATIONS OF PLATFORM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 10, Oct 81 (manuscript received 15 Dec 80) pp 55-57

PAVLOVSKIY, M. A. and RYZHKOV, L. M., Kiev Polytechnic Institute

[Abstract] Reversal of the angular momentum is a conventional method of drift self-compensation in 2-gyro devices, in which two gyros with opposing angular momenta are, moreover, used for this purpose. Assuming steady angular oscillations of the platform, it is demonstrated here that the moment of inertia forces on the gimbal frames and the moment of friction forces at the gimbal shafts do not completely cancel each other. The equations of motion for the system are solved in power series with respect to a small parameter corresponding to weak perturbations. The solution in the second approximation reveals a systematic drift due to friction and thus only a partial compensation of drifts due to nonlinear effects. Elimination of the systematic drift requires zero friction at the shafts of both gimbals. The article was presented by Academician Yu. A. Mitropol'skiy, UkrSSR Academy of Sciences. References 4 Russian.
[92-2415]

HIGH-ENERGY DEVICES, OPTICS AND PHOTOGRAPHY

UDC 535.242.2

INTEGRAL HIGH-TEMPERATURE PHOTOMETER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 23 Jun 80) p 248

SMOLINSKIY, Ye. S.

[Abstract] A photometer has been developed for measuring the transmission as well as the absorption and the scattering of light by objects over the 293-523 K temperature range. It consists of three concentric spherical shells bolted together, a yoke carrying two photomultipliers and an optical system for visual inspection of the test specimen inside through a window of frosted glass, and a set of two other optical systems for inspection of the probing light beam through a quartz window. The inner sphere, 180 mm in diameter, is the measuring device and has its inside surface coated with magnesium oxide. The second sphere is the heater and the outside sphere is the thermostat. The test specimen with thermocouples for temperature control is held inside on the tip of a rod passing through a hole through all three spheres and connected to a manipulator mechanism outside. The spectral range of the instrument is 200-1100 nm, determined by the spectral range of the monochromatic SF-4 light source, by the reflection coefficient of the MgO coating, and by the integral sensitivity of the FEU-28 and FEU-39 photomultipliers in the receiver system. Thermal equilibrium inside the cavity is reached after 5 min. The error of the instrument, at the highest temperature (maintainable within 0.5%), is 1-2%.

Figure 1.

[82-2415]

UDC 535.322.4(088.8)

SET OF INSTRUMENTS FOR MEASURING ABSORPTION OF LIGHT

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 31 Mar 80) p 241

GUL'BINAS, Y. A., ZHILENIS, A. A., KRAUYALIS, R. Yu., MALDUTIS, E. K. and REKSNIS, Yu. Y.

[Abstract] A set of instruments is available for measuring the local absorption of monochromatic light ($\lambda = 1.06 \mu\text{m}$) by translucent solid and liquid media such as extra-pure glass and various optical-grade crystals. It includes a neodymium pulse laser (wavelength $1.06 \mu\text{m}$, pulse duration 1 ms), an LG-38 gas laser (wavelength $0.63 \mu\text{m}$) and an S8-11 memory oscilloscope for interferogrammetry. An absorption coefficient from 10^{-6} to 10^{-1} cm^{-1} can thus be measured in 1 cm^3 large specimens, with a maximum density of pulse laser radiation in such specimens up to 100 kJ/cm^2 . The instruments are arranged on three shelves of an L-stand. They operate from a $220/380 \pm 10\% \text{V} - 50 \text{ Hz}$ line, drawing a peak power of 10 kW. The set weighs 1500 kg. Figure 1.
[82-2415]

UDC 621.555.6(088.8)

CRYOTHERMOSTAT FOR OPTICAL STUDIES AT TEMPERATURES FROM 77 TO 400 K

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 31 Aug 79, after revision 19 Nov 80) pp 214-215

ASKAROV, P. A., YEVSTROPOV, V. V., MALKIN, A. S. and SHERNYAKOV, Yu. M.,
Physico-Technical Institute, USSR Academy of Sciences, Leningrad

[Abstract] The construction of a cryothermostat with liquid nitrogen, for temperature control during optical measurements over the 77-400 K temperature range, has been improved so as to eliminate optical interference along the path of the probing light beam as well as the possibility of variations in the liquid level below the test specimen. The device is made of glass and thermally insulated by a vacuum jacket. It consists of a liquid-nitrogen container with overflow tube and a heating chamber closed on top by a ground stopper. Through that stopper passes a rod holding the specimen between two heater plates inside the chamber and a tube for passing nitrogen vapor from the chamber back into the liquid-nitrogen container. The position of the specimen above the liquid level in the chamber is regulated by means of a remote manipulator. The capacity of the chamber built according to this design is 1250 cm^3 . With a vacuum of 10^{-6} torr maintained in the jacket, the liquid nitrogen must be replenished only once every hour. The temperature can be maintained constant within 0.05 K, it was maintained at 120 K for 24 h. Figure 1, references 4 Russian.
[82-2415]

UDC 621.373.826

ABSORPTION CELL FOR HELIUM-NEON LASER WITH I₂¹²⁷

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 10 Jun 80) p 205

KOLOMNIKOV, Yu. D. and MOGIL'NITSKIY, B. S., State Scientific Research Institute of Metrology, Novosibirsk

[Abstract] An absorption cell containing iodine vapor is used for producing nonlinear resonances in a He-Ne laser at the 0.63 μm wavelength. Such a cell is made of quartz, which hardly interacts with iodine, with Brewster windows glued on and an inlet knee tap soldered on. A long life is ensured by bonding the windows to the cell with high-temperature K400 resin. The cell is then degassed before pure iodine is admitted to the knee tap, and subsequently sealed off the evacuator. The iodine remains completely adsorbed in the knee and fills the cell only during laser operation. Such a cell, 40 cm long and 10 cm in diameter, with a 1 cm^3 large space in the knee tap has already been operating for 18 months with a 1 m long laser resonator cavity. The knee tap is heated to 30-40°C and the cell is heated to 200°C. References 2 Russian.
[82-2415]

UDC 539.107.4

GEOMETRICAL FEATURES OF OPTICAL WAVEGUIDES WITH TOTAL INTERNAL REFLECTION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 15 Feb 80) pp 175-178

RADKEVICH, I. A., SIN'GOVSKIY, A. V. and TKACH, N. G.

[Abstract] The performance of optical waveguides with total internal reflection is analyzed, for the purpose of reconciling sometimes contradictory design recommendations. Three types of waveguides between the scintillator (source) and the photomultiplier (receiver) are considered: 1) a "fish tail" waveguide with a uniform cross section, 2) a "fish tail" waveguide with a transition to a cylindrical one on the receiver side, 3) a flat waveguide with a rectangular cross section uniformly increasing from source to receiver. Their efficiency as a function of transverse dimension and reflection coefficient as a function of incidence angle were measured, with a laser beam entering such waveguides made of 2 mm thick plexi-glass and revealing the lossy regions. A waveguide with widening cross section is found to be inefficient when the refractive index of its material is larger than that of the scintillator material, but to be slightly more efficient than a waveguide with uniform cross section in the opposite case. With incidence at a 67° angle the reflection coefficient will drop below 0.97 at an unfinished surface and down to 0.90 at a polished surface. In the case of multiple reflection such a decrease signifies high losses and,

therefore, surfaces of optical waveguides supplied from a factory should not be further treated. Figures 6, references 4: 2 Russian, 2 Western.
[82-2415]

UDC 621.382.029.74

WIDEBAND FAST-RESPONSE RECEIVER OF ELECTROMAGNETIC RADIATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 11 Oct 79, after revision 12 May 80) pp 165-167

CHERNYAKOV, V. N. and KUKHTEVICH, V. I.

[Abstract] Improvements have been made in a welded junction of a tungsten needle and a nickel bar sensitive to radiation from a CO₂-laser. They include polishing the active nickel surface and sharpening the needle point to 0.05 μm radius by etching in 1.0 N NaOH solution with 6 V-50 Hz voltage. The junction is then heat treated in air, electrically with the aid of a d.c. generator and a resistive regulating circuit. Such junctions were found to be capable of detecting millimeter-wave and infrared radiation with sensitivity of 0.1 and 5 V/W respectively. The detection mechanism is linked to the temperature dependence of the junction resistance. The polarity of the output voltage depends on the polarity of the bias voltage. It is the same for junctions with resistances below 100 ohms, corresponding to tunnel conduction. It is opposite for junctions with resistances above 300 ohms (except near zero voltage), corresponding to conduction beyond the energy barrier. The response speed of both types of junctions is better than 1 ns. Experimental data confirm the theoretical analysis. Figures 4, references 2: 1 Russian, 1 Western.
[82-2415]

UDC 621.317.39:535.29

DEVICE FOR MEASUREMENT OF LASER RADIATION ENERGY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 3 Jul 79) pp 159-160

LISICHENKO, V. I. and CHERNOBAY, V. A., Institute of Mechanics,
UkSSR Academy of Sciences, Dnepropetrovsk branch

[Abstract] A device is proposed for measuring the energy of the part of a laser pulse from the time emission starts to the time an external signal appears. It consists of a photocell detector and electronic signal processing system. The latter includes an integrating RC-circuit, transistor switch, flip-flop, storing capacitor, d.c. amplifier, and measuring circuit with microammeter and light emitting diode as flip-flop state display. With switching speed of approximately 0.1 μs, this device should be capable of measuring

the energy of part of a laser pulse within time intervals from 10 μ s to 1 ms with 2% accuracy. Figure 1, references 2 Russian.
[82-2415]

UDC 537.533.3+621.303+621.38

ELLIPTICAL ELECTROSTATIC REFLECTOR FOR FORMATION OF LOW-ENERGY POSITRON BEAMS

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 4 Dec 79) pp 150-152

ARIFOV, P. U., AVANOV, L. A., ISMAILOV, Sh. F., KOTOV, A. A., KREMKOV, M. V., MAKOV, N. V., POKROVSKIY, V. V., SADYKOV, R. A. and SHEVCHENKO, A. V., Institute of Electronics, UzSSR Academy of Sciences, Tashkent

[Abstract] A device for formation of low-energy positron beams has been built, namely an electrostatic reflector with a long focal distance consisting of two confocal elliptical electrodes placed in vacuum. A radioactive isotope as a positron source is placed in the first (near) focus. A target is placed in the second (far) focus. The part of the neutron flux not reflected but moving from the source to the target directly along the axis is absorbed by an auxiliary shield placed at some distance behind the first focus. The applications of this device are limited by aberration due to the finite size of any positron source. The device was tested with a 2γ -spectrometer in counting annihilation γ -quanta, using a 150 μ Ci Na²² positron source and applying to the reflector electrodes a voltage from 5 to 20 kV. The count rate was found to depend on the reflector voltage and also to be different for different targets with the same reflector voltage, owing to different reflection coefficients for slow positrons with different atomic numbers. Figures 3, references 7: 5 Russian, 2 Western.

[82-2415]

UDC 621.373

GENERATORS OF NANOSECOND PULSES OF FAST ELECTRONS WITH UP TO 500 keV ENERGY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 3 Jun 80) pp 145-147

BELKIN, N. V., KOLESOV, V. I. (deceased) and KHUDYAKOVA, L. N.

[Abstract] A study was made to determine the feasibility of using the commercially produced IMA-150E 150 kV vacuum cube at higher voltages in accelerators. Electron pulse beams of 1.5-2.5 ns with rise time of approximately $5 \cdot 10^{14}$ V/s, with energy up to 500 keV and current amplitude up to 1200 A, were generated by means of a step-up pulse transformer and either a

500 kV discharger with peaking circuit or a dual shaping line. In the latter case it is possible to generate electron pulses of shorter duration without attenuation of the beam by means of filters. Figures 3, references 7 Russian.

[82-2415]

UDC 539.1.074.22

CYLINDRICAL IONIZATION CHAMBER FOR SPECTROMETRY OF LOW-ENERGY (0.1-3 MeV) GAMMA RADIATION

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 19 Feb 80) pp 49-51

DMITRENKO, V. V., LEBEDENKO, V. N., ROMANYUK, A. S. and UTESHEV, Z. M.,
Moscow Physico-Technical Institute

[Abstract] Existing devices for spectrometry of low-energy (0.1-3 MeV) gamma radiation are detectors built with Ge crystals and scintillation counters built with NaI or CsI crystals. The former have high resolution but are too small, while the latter are large and record effectively but have low resolution. A detector has been developed, therefore, which combines fairly large sensing volume with fairly high resolution. It comprises an array of cylindrical ionization chambers containing compressed xenon. An experimental device was built consisting of a 50 cm long steel tube 6 cm in diameter with 0.5 mm wall thickness and a filament anode 100 μm in diameter mounted inside on ceramic insulators and connected to a charge-sensitive amplifier outside. The steel tube is mounted inside a protective aluminum jacket through Teflon spacers. The performance of such a detector is determined by the properties of xenon, namely its atomic number $Z = 54$ and high compressibility to density of 1 g/cm³ under pressure of only 60 atm at 20°C. The electron drift time, 0.7-0.8 $\mu\text{s}/\text{cm}$ in pure xenon, can be shortened by addition of a molecular admixture such as 0.3% H₂. The spectrometer channel is a conventional one consisting of the charge-sensitive BSU2-97 amplifier-shaper and AI-256-6 analyzer. The instrument was calibrated and tested with various monoenergetic sources (Co⁵⁷, Co⁶⁰ + Na²², Cs¹³⁷) and with xenon condensed to 0.27 g/cm³ under pressure of 37 atm, maximum technically feasible in the experimental equipment. The authors thank A. M. Gal'per for his interest and assistance. Figures 4, references 1 Russian.

[82-2415]

UDC 53.08.004.12:539.26

MULTIELECTRODE TIME-OF-FLIGHT NEUTRON DIFFRACTOMETER FOR 'FAKEL' ACCELERATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 3 Mar 80) pp 38-41

VINDRAYEVSKIY, B. A., ISHMAYEV, S. N., PODSHIBYAKIN, V. D., SADIKOV, I. P.,
SEVEROV, M. N. and CHERNYSHOV, A. A.

[Abstract] A time-of-flight diffractometer has been incorporated in the "Fakel" neutron accelerator at the Institute of Atomic Energy imeni I. V. Kurchatov for measurement of neutron scattering by substances in the condensate state. It contains, in addition to a source of slow neutrons and a collimator, two diametrically spaced arrays of eight He^3 neutron counters 9.5° apart and a detector of the straight-forward neutron beam. A high-intensity beam of fast neutrons is generated by retardation of accelerated electrons at a heavy tantalum or uranium target, whereupon this beam is moderated by water surrounding the target and the duration of pulses of thermal neutrons is regulated by forward or backward sliding of a cadmium absorber plate. With the aid of the detector it is possible to measure the wavelength spectrum of neutron flux and the scattering cross section over a wide range of energy from 0.001 to a few eV. The wavelength is determined from the transit time t , with high resolution $\Delta t/t = 0.2-1\%$, the distance $L = 6.2$ m from neutron source to specimen and the distance $l = 0.3$ m from specimen to detector. The diffractometer was tested on specimens 1 cm in diameter of polycrystalline Al_2O_3 and liquid Cd^{111} isotope, with control measurements for accuracy determination made on nickel powder. The authors thank A. Ye. Golovin, Yu. I. Zaytsev, A. B. Tyugin for designing the radio-electronic equipment and V. V. Golovnev, I. A. Zverer, A. V. Lipatov, V. G. Timokhov for setting up the diffractometer and assisting with the measurements. Figures 3, references 3: 2 Russian, 1 Western.

[82-2415]

UDC 621.384.64

POSITRON SOURCE FOR LINEAR ACCELERATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 16 Jul 80) pp 29-31

ARTEMOV, V. I., VISHNYAKOV, V. A., DEM'YANENKO, G. K., DOBROMIROV, S. A.,
KOBESKIY, V. M., PEYEV, F. A. and FISUN, A. N. (deceased)

[Abstract] The positron source for the Khar'kov Linac in operation since 1968 has been replaced in 1979 by a new one with more extensive capabilities. Positrons are generated in a converter by photons and high-energy electrons. The converter is a water-cooled tungsten disk 5.5 mm thick, nearly optimum for a maximum positron yield with a primary electron beam of 140-150 MeV energy.

Heat dissipation is facilitated by a copper sink which covers 90% of the converter surface, leaving an open area 5 mm in diameter at the center. No deterioration of the vacuum has been noted after 250 h of operation. The positron beam, with inherently wide variation of the transverse momentum, is necessarily focused by a special device which also matches its phase volume to the accelerator acceptance. This device consists of an axisymmetric lens and a long solenoid. With a conversion ratio of $2 \cdot 10^{-4}$, a positron beam of 1,200 MeV energy with current of 10 nA can now be produced at the accelerator exit. Figures 3, references 5: 3 Russian, 2 Western.

[82-2415]

UDC 621.376.5

HIGH-VOLTAGE PULSE-TYPE MODULATOR FOR INUS-2 HIGH-CURRENT ELECTRON ACCELERATOR

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 23 Jun 80) pp 27-28

GUSEV, O. A., KOVALEV, V. G., MARKOV, V. B., MELLEKH, Ye. M., PAVLOV, Ye. P., PECHERSKIY, O. P., POLYANSKIY, M. Yu. and STEKOL'NIKOV, B. A.

[Abstract] A high-current electron accelerator has been built with pulse modulation of the electron beam. The modulator is a current generator with an inductive energy storage in a magnetic field which can limit the beam amplitude and lengthen the beam duration. The accelerator cathode and anode are ring electrodes designed according to Pierce optics. The energy storage has an inductance of 60 μ H and is charged rapidly through a low-voltage 12,000 μ F capacitor bank. The discharger consists of three mercury-arc stages: the first one with a 60 μ F - 30 kV capacitor bank, the others with resistive voltage dividers for regulating the pulse transmitted from the energy storage through a pulse transformer to the accelerator diode. The source of electrons is a thermionic cathode with emitter array of tungsten-rhenium alloy wires heated through a relay and pnpn-type switches. The heater circuit is protected by two capacitors and a time relay against interference from the high-voltage accelerating pulse. The accelerator can produce electron beams of energy up to 150 keV and duration up to 1 μ s with a current up to 400 A. In operation for several months already, the modulator has been found to reliably break currents as high as 70 kA at voltages up to 15 kV. Figures 4, references 2 Russian.

[82-2415]

UDC 621.384.6

HIGH-CURRENT NANOSECOND ELECTRON ACCELERATOR WITH STABLE 1 MeV ENERGY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 7 Jul 80) pp 23-26

ZHELTOV, K. A., MALYGIN, A. V., ROZOV, V. I. and SHALIMANOV, V. F.

[Abstract] A nanosecond direct-action electron accelerator has been built with stabilization of the electron energy at levels up to 1.2 MeV. Its supply module contains two heteropolar stabilized d.c. voltage sources, a primary energy storage consisting of two 1 μ F - 10 kV capacitors, and a 25,000 pF - 60 kV capacitor serving as secondary energy storage. The high-voltage module contains a discharger, a vacuum diode, a charging-shaping line on pulse transformers with a characteristic impedance of 30 ohms and electrical length of only 2 ns, just slightly longer than the discharger switching time, and a transforming line. Saturable cores in the charging-shaping line provide nonlinear inductance ensuring stable controllable firing of the discharger. The transforming line is over 2 m long and bent around so as to fit into a smaller package and, at the same time, facilitate regulation of the discharger interelectrode gap by means of a "trombone" slider. It terminates in a funnel connected through the vacuum diode to a high-current explosive-emission cathode. The vacuum diode generates x-ray bremsstrahlung, the electron beam exits into the atmosphere through a beryllium or titanium window. Signals are received from capacitive voltage dividers in the form of copper strips built into the tubular transforming line. The accelerator has been tested and found to operate reliably. The authors thank A. I. Petrenko for assisting with the measurements and N. S. Gantkovskaya for designing the accelerator. Figures 4, references 8 Russian.

[82-2415]

UDC 621.384.6.038.628

ACCELERATOR OF HEAVY IONS TO 1 MeV ENERGY

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 1 Jul 80) pp 19-21

NEZUGLYY, V. V., BREDIKHIN, M. Yu., ZELENSKIY, V. F., IL'YENKO, B. P., NEKLYUDOV, I. M. and KHORENKO, V. K.

[Abstract] An accelerator of heavy ions has been built which includes an electric-arc hot-cathode ion source and an injector of multiply charged ions. It also includes a mass separator, a beam shaper, an acceleration tube and a target chamber. A pair of electrostatic plates and a pair of quadrupole lenses serve for respectively correcting and matching the ion beam with respect to the acceleration tube. Included are also a Farady cylinder and evacuating diffusion

pumps. The device was tested on argon and chromium ions and found to produce ions of up to 1 MeV energy with an accelerating voltage of 200 kV. At a residual gas pressure of $5 \cdot 10^{-6}$ torr in the acceleration tube, 80% of all Ar³⁺, Ar⁵⁺, Cr⁵⁺, Cr⁶⁺ ions pass through the tube without a change of charge. Experimental data have also been obtained with this device on the swelling of some materials such as nickel under ion bombardment. Figures 4.

[82-2415]

UDC 662.997:666.11.01:697.1

OPTICAL CHARACTERISTIC OF SOLAR ENERGY COLLECTOR

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 9 Jun 80) pp 27-32

POPEL', O. S., FRID, S. Ye. and SHPIL'RAYN, E. E., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] The dependence of efficiency of solar energy collectors on their optical characteristics is analyzed on the basis of the equation of steady-state heat balance. Particularly significant are the absorption coefficient of the collector plate and the transmission coefficient of its protective cover. The performance of various cover materials such as polymers and glasses, depending on thickness and number of layers, has been evaluated numerically on the basis of theoretical relations taking into account refraction and multiple reflection as well as variations of radiation intensity in time and deviations of radiation incidence from normal. Glasses have better thermal characteristics than translucent polymers and, as results of calculations indicate, 2- or 3-layer protective covers made of glass with optical thickness of 0.01 and refractive index close to 1.0 will yield higher average efficiency than conventional 1-or 2-layer protective covers made of glass with optical thickness of 0.1 (window glass). The effects of dustiness of the glass cover and of the shading of the collector plate by its lateral walls can only be estimated and are accounted for by correcting the transmission coefficient downward.

Figures 3, table 1, references 5: 4 Russian, 1 Western.

[48-2415]

FLUID MECHANICS

UDC 539.376

DIVERGENCE OF WING WITH REVERSE SWEEPBACK

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 81 (manuscript received 7 Jan 80) pp 133-138

SEYRANYAN, A. P., Moscow

[Abstract] An aircraft wing with reverse sweepback is considered. The phenomenon of divergence in an air stream is analyzed, with the wing regarded as an elastic beam and with the nonconservative aerodynamic forces described according to the theory of a carrier foil. The corresponding boundary-value problem is solved by the method of perturbations, with the ratio $\chi = D_m e_m / C_m L \tan \alpha$ as the small parameter (D_m - mean flexural stiffness, C_m - mean torsional stiffness, e_m - mean distance from the neutral axis to the line of aerodynamic foci, L - span of the wing, α - sweepback angle). Relations are derived on this basis for the critical divergence rate and its dependence on the various wing parameters. The author thanks F. L. Chernous'ko for his interest and helpful comments. Figures 2, references 10: 4 Russian, 6 Western.
[93-2415]

UDC 532.529

CHANGES IN WAVE STRUCTURE FOR BODIES IN SUPERSONIC TWO-PHASE FLOW

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 260, No 4, 1981
(manuscript received 22 Jan 81) pp 821-825

YANENKO, N. N., academician, ALKHIMOV, A. P., NESTEROVICH, N. I.,
PAPYRIN, A. P. and FOMIN, V. M., Institute of Theoretical and Applied Mechanics,
Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] An experimental study was made of changes in the wave pattern for supersonic flow of gas with suspended solid particles past solids. A stream flowing at a velocity of Mach 3 was produced by a nozzle with a pressure of 8.5 atm and at a temperature of 260 K in the forechamber. In the vicinity of

the critical $5 \times 20 \text{ mm}^2$ nozzle section were cylinders, spheres, or wedges made of stainless steel and suspended in the gas were aluminum particles, lycopodium dust, acrylic glass particles, or bronze particles with mean diameters of 10, 25, 200, and $100 \mu\text{m}$ respectively. A new phenomenon was discovered, namely strong perturbation of the leading shock wave due to reentry of rebounded particles, especially heavier ones and even at very low concentrations, into the supersonic flow zone. On the basis of shadow photographs, a physical model is proposed for interpretation of this phenomenon in which a quasi-conical density jump forms with pressure rise transmitted from the subsonic zone through the wake of particles, this cone having an angle larger than the corresponding Mach angle. Calculations assuming velocity of this "gas cone" equal to the velocity of particles agree closely with experimental data. Figures 3, table 1, references 7: 5 Russian, 2 Western.

[64-2415]

UDC 533.601.155

APPROXIMATE METHOD OF DESCRIBING HYPERSONIC FLOW IN VICINITY OF PLANE AND AXISYMMETRIC BODIES

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 40, No 6, Jun 81
(manuscript received 6 Dec 79) pp 1106-1107

[Annotation of article deposited at the All-Union Institute of Scientific and Technical Information, No 356-81 Dep, with 8 bibl. ref.]

SKUTOVA, I. V. and TYUTYUMA, V. D.

[Abstract] The approximate expression $P - P_\infty = P_s(\psi) \sin^2 \theta$ for pressure distribution over flat and sharp or blunt axisymmetric bodies in oncoming streams with high Mach number (θ -angle between velocity vector and direction of stream) is substituted for one of the momentum equations in the system of differential equations describing adiabatic hypersonic equilibrium flow of gas past such bodies. Upon an appropriate change of variables, with $P_s(\psi)$ and $S(\psi)$ approximating the ρv -function (ρ -density and v -specific volume of the gas) determined, this modified system of equations reduces to a Cauchy problem of ordinary differential equations with initial and boundary conditions at the body surface.

References 3: 2 Russian, 1 Western.

[70-2415]

UDC 536.24+536.712

SOLUTION TO PROBLEMS OF STEADY-STATE ISOTHERMAL HEAT AND MASS TRANSFER IN CLOSED SPACE

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 7, Jul 81 (manuscript received 13 Aug 80) pp 64-67

MINUKHIN, L. A., candidate of technical sciences, docent, Chair of Food Industry Machines and Equipment, Sverdlovsk Institute of Economics

[Abstract] The three-dimensional problem of steady-state isothermal mass transfer for a vapor-gas mixture within a space between evaporation and condensation surfaces is formulated in the most general form, the corresponding differential equation is reduced to the standard Laplace equation, and the latter is solved for a harmonic function representing the unknown mass distribution of either one of the mixture components. The two-dimensional problem and the one-dimensional problem, with their respective solutions, constitute special cases with boundary conditions corresponding to specific shapes of the heat exchangers. References 4 Russian.

[50-2415]

UDC 533.6.013.42

IMPACT OF AXISYMMETRIC BODY ON SURFACE OF COMPRESSIBLE FLUID

Kiev DOKALDY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 9, Sep 81 (manuscript received 24 Oct 80) pp 44-48

KUBENKO, V. D., Institute of Mechanics, UkrSSR Academy of Sciences

[Abstract] Penetration of an axisymmetric body into a compressible fluid, upon impact on the fluid surface at zero angle of attack (normal incidence), is analyzed by the method of integral transformations. Accordingly, Laplace transformation of the corresponding second-order differential equation for the potential yields a solution from which, through Bessel transformation of a cylinder function, the radial distribution of hydrodynamic pressure on the surface can be determined as a function of time. Penetration, at a constant velocity, of a cone and of a sphere are considered as special cases. A solution for the general case requires the solution of two auxiliary boundary-value problems, namely: either the radial distribution of the strain rate at the surface and its variation in time or the radial distribution of the pressure at the surface and its variation in time given, and the other to be found. References 15 Russian.

[51-2415]

UDC 533.6.011.5

NUMERICAL STUDY OF SUPERSONIC JET FLOW AROUND SHARP CONES

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 10, Oct 81
(manuscript received 14 Jun 79) pp 133-136

GALINSKIY, V. P., KUSHNIR, G. G. and TIMOSHENKO, V. I., Institute of Engineering Mechanics, UkrSSR Academy of Sciences, Dnepropetrovsk

[Abstract] An investigation is made of patterns of flow of underexpanded supersonic inviscid jets around solid bodies. To clearly delineate the particulars of flow, bodies in the form of pointed cones are considered, since the structure of unbounded supersonic flow around such shapes is fairly simple. The analysis covers the flow structure, the shape of the jet boundary and the pressure distribution on the surface of the cone as a function of the degree of underexpansion and distance between the nozzle tip and the cone. Curves are given showing calculated pressure distributions. Figures 5, references 10: 9 Russian, 1 Western.

[62-6610]

UDC 532.516

FORCE ACTING ON SOLID IN VISCOUS LIQUID

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 5, Sep-Oct 81
(manuscript received 21 May 80) pp 840-844

BERDICHEVSKIY, V. L., Moscow

[Abstract] The problem of calculating forces and moments acting on an absolutely solid body as it moves in an ideal incompressible potential flow either unbounded or bounded by stationary walls has been reduced by Kelvin and Tate to a problem of calculating the kinetic energy of the liquid in cases where the kinetic energy is finite. The author considers the problem of finding a universal expression that relates force, moment, kinetic energy and dissipation for arbitrary motion of a viscous liquid, assuming dependence not only on the instantaneous characteristics of motion, but on the previous history of motion as well. It is shown that the Kelvin-Tate formulas can be generalized to the case of a solid moving in a viscous liquid. The problem of an analog of the Onsager reciprocal relation for media with memory is discussed. References 3 Russian.

[63-6610]

UDC 532.516

FORCE ACTING ON CYLINDER IN STEADY VISCOUS FLOW AT LOW REYNOLDS NUMBERS

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 5, Sep-Oct 81
(manuscript received 23 Jan 80) pp 845-848

VASIL'YEV, M. M., Moscow

[Abstract] The author considers the problem of plane-parallel steady flow of a viscous incompressible fluid past a circular cylinder at low Reynolds numbers. The analysis is based on the Navier-Stokes equations with boundary conditions and an auxiliary system of equations (linear Oseen equations). A rigorous derivation is given for Lamb's formula for head drag with estimation of the residual term. References 9: 7 Russian, 2 Western.
[63-6610]

MECHANICS OF SOLIDS

UDC 624.07:534.1

VIBRATIONS OF TIMOSHENKO BEAM LYING ON AFTEREFFECT-ELASTIC BASE

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 81 (manuscript received 13 Aug 79) ppp167-179

MURAVSKIY, G. B., Moscow

[Abstract] The dynamic behavior of a Timoshenko beam lying on a deformable base is analyzed for the case of an elastic lag relation between applied pressure distribution and resulting base displacement distribution along the beam as functions of time. The corresponding integral equation is assumed to have a Biot kernel, this kernel being an integral exponential function. General solutions are obtained for the Feucht model and the Maxwell model of the base material. The results are applied to the special case of vibrations under a force stationary in space but varying harmonically in time. The solution is compared with that obtained with the aid of a Fourier integral and by application of the causality principle, for a linear system under a momentary unit impulse. Figures 5, references 9: 4 Russian, 5 Western.

[93-2415]

UDC 539.3

DESIGN OF PROFILED BLADES WITH STIFFENERS FOR RADIAL SUPERCHARGERS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 81 (manuscript received 3 Jul 79) pp 159-166

PUKHLIY, V. A., Moscow

[Abstract] A hollow supercharger blade, consisting of two cylindrical panels with different curvatures joined along their lateral edges through stiffener bars on the entrance side and on the exit side, is designed for strength. Calculations are based on the Vlasov-Donnel linear differential equations in the theory of shallow shells and the equilibrium equations for the stiffeners. The state of stress and strain is determined accordingly, with the hypothesis

of plane section assumed to be valid here. The corresponding boundary-value problem is solved analytically by first being put in the divergence form, according to the method of integral relations, and then by successive approximations with variable coefficients. A system of orthogonal Jacobi polynomials is used as the system of linearly independent approximating functions satisfying the boundary conditions of rigidly clamped oblique blade edges and also as the weighting functions. The algorithm of this design procedure has been programmed in FORTRAN for an M4030 computer. A typical design of such a blade is shown according to which a prototype has been built and tested, with round rods as stiffeners. The difference between calculated and measured stress distributions does not exceed 20%. Figures 4, references 7 Russian.
[93-2415]

UDC 539.3

ASYMPTOTIC BEHAVIOR OF EQUILIBRIUM OF GEOMETRICALLY NONLINEAR MOMENT-FREE SPHERICAL SHELL UNDER LIGHT LOADS

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian
No 5, Sep-Oct 81 (manuscript received 25 Aug 80) pp 149-158

SRUBSHCHIK, L. S., Rostov-na-Donu

[Abstract] A spherical membrane is considered under a uniformly distributed tracking load with a small positive or negative value of the pressure parameter, its edge contour either rigidly clamped (zero displacements) or freely supported. All moments in the Reissner integrodifferential equations are disregarded, which corresponds to a very small flexural stiffness or very small deformations of the median surface. Positive solutions to the boundary-value problems, corresponding to equilibrium under meridional tension forces only, are obtained in asymptotic representations with the relative membrane thickness as the small parameter. The results are compared with those obtained by numerical solution on a BESM-6 high-speed computer and close agreement is found within the given range of parameters for membranes with small central angles. The solutions for membranes are, furthermore, reconciled with solutions for thin elastic shells. The author thanks S. A. Alekseyev, A. S. Grigor'yev and V. I. Mayskin for the helpful discussions. References 23: 16 Russian, 7 Western.
[93-2415]

BUCKLING OF ELASTIC CYLINDER UNDER TORSION AND COMPRESSION

Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA TVERDOGO TELA in Russian No 5, Sep-Oct 81 (manuscript received 27 Feb 79) pp 78-84

ZUBOV, L. M. and MOISEYENKO, S. I., Rostov-na-Donu

[Abstract] Simultaneous torsion and compression of a solid circular cylinder with a load-free lateral surface is analyzed, assuming first that it is made of an isotropic elastic incompressible material. The subcritical state is determined from the system of ordinary differential equations describing the perturbation of neutral equilibrium, with constraints at the cylinder bases equivalent to hinge supports for normal displacement and sleeve supports for axial displacements. The solution yields the buckling mode and critical loads. The critical dependence of twisting moment on compression force is then calculated for the more general case of a non-Hookean material. Numerical results obtained in this way are compared and found to agree closely with the elementary theory of stability. Figures 3, references 4 Russian.

[93-2415]

SOLUTION OF NONAXISYMMETRIC PROBLEMS IN STATICS OF SHELLS OF REVOLUTION WITH SMALL RIGIDITY

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 10, Oct 81 (manuscript received 2 Feb 81) pp 30-34

GRIGORENKO, Ya. M., associate member, UkrSSR Academy of Sciences and TIMONIN, A. M., Institute of Mechanics, UkrSSR Academy of Sciences

[Abstract] Orthotropic multilayer shells of revolution with small rigidity are considered and their geometrically nonlinear deformation by nonaxisymmetric or local loads is analyzed, with transverse shear taken into account according to a Timoshenko model. The corresponding complete system of equations of the nonlinear theory, where the first derivative of one Lame coefficient with respect to the other orthogonal coordinate becomes zero for shells of revolution, is reduced to a resolvent system of 10 nonlinear first-order partial differential equations. The integral characteristics of the temperature field here are determined by the thickness and the physico-mechanical properties of the shell layers. This system of equations is further reduced to one of $10(N + 1)$ ordinary differential equations, $2N + 1$ being the number of terms in the sums of trigonometric functions to which the products of trigonometric functions have been converted (only $N + 1$ terms in these sums are retained). The latter system is now solved by successive approximations, with the initial state of a shell

under no load serving as the zeroth-order approximation, the first-order approximation corresponding to the linear formulation of the problem, and the nonlinear functions representing additional loads. Since only the particular solution needs to be successively refined in this process, only 10 equations must be simultaneously integrated on each step. The algorithm of such a solution by discrete orthogonalization has been programmed in ALCOL-GDR for a BESM-6 high-speed computer. Here the method is demonstrated on a horizontal conical shell of variable thickness, rigidly clamped around its smaller base and loaded by a vertical force distributed over only an arc of the larger base circle. Figures 3, references 4 Russian.

[92-2415]

UDC 539.3

LOSS OF STABILITY OF SPHERICAL SHELLS UNDER EXTERNAL PRESSURE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 260, No 4, 1981
(manuscript received 4 May 81) pp 831-833

BABENKO, V. I. and PRICHKO, V. M., Physico-Technical Institute of Low Temperatures, UkrSSR Academy of Sciences, Khar'kov

[Abstract] An experimental study was made of shallow spherical shells under external pressure and their loss of stability, results of which confirm calculations of the upper critical load according to the geometrical theory and by the method of numerical integration. Shells for this experiment, produced by copper deposition from an alundum crucible under vacuum on precise substrates, had a radius of 100.2 mm and a height of 0.781 mm from the base circle with a radius of 12.5 mm. According to tensile and bending tests performed on flat specimens of this material, its modulus of elasticity is $(0.97-1) \cdot 10^4$ kgf/mm². Measurements of normal displacements revealed a loss of stability at critical load levels somewhat higher than obtained by numerical integration of theoretical equations. In the case of rigidly clamped shells the loss of stability is accompanied by a distinctly audible knock and a distinctly visible symmetric depression. After several oscillations about a buckled equilibrium state in the supercritical range, the deformation results in final reversal of shell curvature. In the case of freely supported shells these processes occur much more slowly and less distinctly. The article was presented by academician A. V. Pogorelov on 4 May 1981. Figures 2, references 6: 5 Russian, 1 Western.
[64-2415]

SOLUTION FOR PROBLEM OF INTERNAL CONTACT BETWEEN ELASTIC CYLINDER AND TWO CONCENTRIC RINGS JOINED BY PRESS FITTING

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: MEKHANIKA in Russian Vol 34, No 3, May-Jun 81 (manuscript received 15 Apr 80) pp 13-24

TEPLYY, M. I., Drogobych Pedagogical Institute imeni Iv. Franko

[Abstract] An analysis is made of the distribution of stresses that arise when predetermined radial and tangential forces are applied over a given angle on the outer surface of a ring into which another ring is forced with outside radius slightly greater than the inside radius of the first ring. Within the inner ring is a disk of radius less than the inside radius of the inner ring, and a concentrated force is applied to the center of the disk normal to the ring surface. The problem is reduced to solution of a system of two integral equations. Numerical results are given. Figures 3, references 5 Russian.

[69-6610]

PENETRATION OF SLENDER BODY INTO METALS AND SOILS

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: MEKHANIKA in Russian Vol 34, No 3, May-Jun 81 (manuscript received 16 Apr 80) pp 25-38

BAGDOYEV, A. G. and VANTSYAN, A. A., Institute of Mechanics, ArSSR Academy of Sciences

[Abstract] An analysis is made of the problem of penetration of a slender solid of revolution into metals and soils taken as initially elastic media. It is shown that a solution assuming an ideally plastic medium behind the destruction front is valid only when energy dissipation on the front can be disregarded. A more exact solution is found by using the shock adiabat equation. The maximum depth of penetration is found for a cylinder terminating in a curvilinear cone. It is shown that when friction is low between the solid and the medium, the equations for the medium retain only the derivatives with respect to radial coordinate. Experiments on penetration of slender solids of the given geometry into various metals and composites give results in good agreement with the derived formulas. The results are generalized to viscoplastic and particulate media. Solutions in the order of the square of the half-angle of the tip of the penetrating body are derived that are valid everywhere except in the immediate vicinity of the free surface of the medium and the tip of the solid. Figures 4, references 22: 19 Russian, 3 Western.

[69-6610]

UDC 539.3

STABILITY OF RIBBED SPHERICAL SHELL UNDER STATIC AND DYNAMIC LOADING BY EXTERNAL PRESSURE

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 10, Oct 81
(manuscript received 2 Jul 80) pp 51-60

AMIRO, I. Ya., Institute of Mechanics, UkrSSR Academy of Sciences, Kiev

[Abstract] An approximate approach is proposed for solving the problem of a ribbed spherical shell with consideration of discrete placement of the ribs. The analysis is based on using linear equations of the theory of structurally orthotropic shells, and comparing the critical forces of general loss of stability with critical forces that correspond to the panel form of buckling. It is assumed that the shell is reinforced by a rectangular network of ribs, and that it has a shallow slope within the limits of the primary dent that arises upon loss of stability. Assymetry of rib placement and forces of inertia in the middle surface of the shell are disregarded. The solution is found by analogy with the method proposed by V. Z. Vlasov for a smooth shell in "Obshchaya teoriya obolochek i yeye prilozheniya v tekhnike" [General Theory of Shells and its Applications in Engineering], Gostekhizdat, Moscow-Leningrad, 1949. The possibility of intensive development of flexures is taken as the criterion of dynamic loss of stability with linearly increasing forces. Simple formulas are derived for a shell identically reinforced in two directions for critical compressive forces under dynamic loading, and an analysis is made of the effect that stiffness of the ribs and spacing between ribs have on the critical forces under static loading, as well as the influence that loading rate has on the coefficient of dynamicity. Figures 4, references 4 Russian.

[62-6610]

UDC 539.3

STABILITY OF LOCALLY LOADED CYLINDRICAL SHELL

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 10, Oct 81
(manuscript received 12 Jun 79) pp 86-92

KRYSKO, V. A. and KOLOMOYETS, A. A., Saratov Polytechnical Institute

[Abstract] The authors consider the stability of a cylindrical shell of circular cross section when a local load is applied along the generatrix over arcs of the directrix, and under external pressure applied in strips on the cylinder. The fundamental state is taken as untorqued. Nontrivial solutions of the stability problem are found by using the Laplace transform method. The proposed method gives the well known classical results of critical loads

for compression along the generatrix applied over the entire cross section and over the entire surface of the shell. Figures 3, references 7 Russian.
[62-6610]

UDC 539.3

STRESSED STATE OF THICK-WALLED NON-CANONICAL SHELLS OF REVOLUTION

Kiev PRIKLADNAYA MEKHANIKA in Russian Vol 17, No 10, Oct 81
(manuscript received 28 Dec 79) pp 120-123

LYALYUK, D. F., Ivano-Frankovsk Institute of Petroleum and Gas

[Abstract] The author considers a non-canonical surface produced by rotation of some contour about a fixed axis where the parametric equation of the contour in the meridional plane including the axis corresponds to a function that conformally maps the area external to a unit circle onto the exterior to the given contour. A perturbation method developed previously for solving boundary value problems of elasticity theory for non-canonical regions is used to study the stressed and strained state of such thick-walled non-canonical shells. The proposed method is illustrated by analyzing the stressed state of a conical quasi-spherical shell formed by rotating an equilateral triangle with rounded corners about an axis of symmetry. It is assumed that this homogeneous isotropic thick-walled shell is loaded by a given internal pressure. Comparison with exact results analytically calculated for a sphere and ellipsoid shows that the proposed technique gives satisfactory accuracy. Figures 2, tables 2, references 8 Russian.

[62-6610]

UDC 539.3:534.1

OPTIMUM DESIGN OF SPHERICAL LATTICEWORK SHELL WITH FIXED FIRST NATURAL FREQUENCY OF AXISYMMETRIC OSCILLATIONS

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 45, No 5, Sep-Oct 81
(manuscript received 2 Oct 80) pp 895-901

PURTOV, V. A. and PSHENICHNOV, G. I.

[Abstract] The authors consider the problem of optimum design of a shell made up of elastic rods that form a dense network of equilateral triangles on a spherical surface (middle surface of the shell). Based on a continuous computational model [G. I. Pshenichnov, "Calculation of Latticework Shells" in: "Issledovaniya po teorii sooruzheniy" (Studies in the Theory of Structures), No 22, Moscow, Stroyizdat, 1976, p 159], the theory of optimum control is used to find how the radius of a thin-walled tubular rod depends on the coordinate

along the meridian of the middle surface when the dimensionless parameter of the first frequency of natural axisymmetric oscillations of the shell is a predetermined quantity, while the functional of the volume of material of the shell is minimized. An example shows that this results in considerable savings of material over a design in which the rods have a fixed cross section.

Figures 3, references 4 Russian.

[63-6610]

TESTING AND MATERIALS

THERMOCHEMICAL SHAPING OF DIAMOND CUTTING TOOLS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Oct 81 p 4

[Text] Moscow--In our time, expensive diamonds are used to provide cutting tools for metal-cutting lathes, drilling machinery and other equipment. They last 10 to 12 times longer than do cutting tools made of extrahard alloys. However, it is not so easy to convert this very hardest of minerals into a working tool and to give it the necessary form. The mechanical method for its conversion has been known for a century and is still being widely used.

"We discovered the thermochemical effect unexpectedly," related Doctor of Geological and Mineralogical Sciences V. Koval'skiy, director of the Geology Institute of the Yakutsk affiliate of the Siberian Department of the USSR Academy of Sciences. While studying how diamonds interact with solids and gases, workers at the Laboratory of Experimental Mineralogy inserted this valuable stone into a thermal furnace after having covered it with a thin iron plate. Upon being heated to 1,000 degrees in a hydrogen atmosphere, the plate sank uniformly into the diamond, which seemed to melt.

As is known, a diamond consists of carbon. On those areas where the mineral came into contact with the plate, the bonds between atoms were broken. Thanks to their small size, the diamond's carbon atoms easily passed through the crystal lattice of the metal and emerged on the surface of the plate. There the carbon reacted to the hydrogen and, having formed a methane gas, evaporated.

In one of their experiments, the researchers covered the diamond facet with an iron plate through which an opening in the shape of a gear had been made. The diamond was then kept in a hydrogen atmosphere at a temperature of 1,200 degrees. After 29 hours the plate penetrated down into the crystal almost one millimeter, while a diamond gear emerged from the opening. It is impossible to form such a component through the use of any other existing method. Now it is no longer a problem to make cutters and microcutters of complex configuration, to make shaped openings in diamonds. This will expand tool industry possibilities considerably.

9643
CSO: 1861/53

UDC 621.646.2:53.084.82

HIGH-PRESSURE VALVE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 21 Apr 80) p 242

ZAKAR'YAYEV, Z. R.

[Abstract] A high-pressure valve has been developed for piezometric or calorimetric test cells where thermophysical measurements are to be made over the 4-600 K temperature range under pressures up to 100 MPa. Its mounting flange carries connections to communicating equipment and a seal for the shut-off needle. The needle passes through a center hole in the flange and a capillary tube carrying the valve seat at one end. On the other side of the flange the needle holder passes through the handwheel. Rotation of the latter under a washer causes the needle to slide up or down as desired, a set of nuts locks it in place. The mounting flange and the needle with the capillary and the valve seat are made of 12Kh18N10T steel, all other valve components are made of BrB2 bronze. Some flexibility has been built into the valve for easier installation. Figure 1.
[82-2415]

UDC 621.317.791

CONTACTLESS TRANSDUCER ShCh4315-03

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 31 Mar 80) p 230

DENISYUK, Yu. L., KOKOVIKHIN, V. G., SMOLIN, A. T., SYTKIK, M. G., TARASENKO, N. D. and YAKOVLEV, N. I.

[Abstract] The ShCh4315-03 instrument is intended for contactless measurement of the amplitude of voltage and current pulses as well as for conversion of the ripple components in rectified voltage during inspection of printed circuits in laboratory or factory. The instrument is portable, in a plastic case, with

the readout device in the form of a pancake coil as the capacitive-inductive sensing element. The latter acts as one capacitor plate, the test piece of conducting material constituting the other. The instrument includes also a signal amplifier and an analog-to-digital converter. Its ranges are 0.5-9 V and 1-90 mA at frequencies of 1 Hz - 500 kHz and at temperatures from 10 to 35°C, with an error not larger than $\pm 25\%$. It operates from a 187-242 V - 50 Hz line, drawing not more than 15 W. Its overall size is 260x65x220 mm³, the connecting cable is 1.5 m long. Figure 1.
[82-2415]

UDC 536.483+536.581.

THERMOSTATIC CELL FOR INTERMEDIATE TEMPERATURES WITHIN 4.2-600 K RANGE

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 23 Jun 80) pp 217-218

MAMALUY, A. A. and MEDYANIK, A. AN., Khar'kov State University

[Abstract] A thermostatic cell has been developed for measuring the temperature dependence of properties of metals over a wide range, from 4.2 to 600 K. It is capable of maintaining the temperature of a test specimen at any point within this range for the time of measurement. It also eliminates the need for re-assembly between measurements and thus the lengthy exposure to room temperature, at which the properties can change irreversibly. It consists of a temperature equalizing bulky copper cup with a lid inside a Dewar flask. The test specimen and thermometers are held inside the cup on a rod passing through the lid as well as through the stopper of the Dewar flask. Vacuum between the two walls of the Dewar flask is produced by adsorbent carbon filling the bottom, while the outer wall is cooled with liquid helium or nitrogen. This general-purpose cell can be used for measuring the temperature dependence of the density of pure metals as well as the temperature dependence of the electrical resistivity of specimens with excess vacancies. The procedure is similar for temperatures below and above 300 K, but more heater power is required in the upper range. Figure 1, references 2 Russian.

[82-2415]

UDC 537.311.35/37

VACUUM-TIGHT ELECTRICAL LEADS INTO HIGH-PRESSURE CHAMBER

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 26 Jun 80) p 204

SUKHOPAROV, V. A. and TELEPNEV, A. S., Institute of High-Pressure Physics,
USSR Academy of Sciences, Troitsk

[Abstract] A construction of vacuum-tight electrical leads into a high-pressure chamber is described which ensures reliable operation not only with liquids but also with gases as the pressure transmitting medium inside the chamber. This is achieved by isolating the epoxy seal around the copper wires (coated with vinyl enamel) through the gasket from the active space in the chamber by an indium washer which has been precompressed by a piston under a nut around the gasket. This lead assembly was tested with a pressure chamber containing molecular hydrogen and found to perform satisfactorily under pressures up to 17 kbars on one side and vacuum of the order of 10^{-2} bar on the other at temperatures from 4 to 300 K. Figure 1, references 3 Russian.
[82-2415]

UDC 537.57:621.793.184

DEVICE FOR PARTIAL IONIZATION OF STREAM OF EVAPORATED MATERIAL UNDER DEEP VACUUM

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 9 Jun 80) pp 201-203

GRITSKEVICH, R. N. and OBUKHOV, V. Ye., Institute of Electronics, BSSR Academy of Sciences, Minsk

[Abstract] An ionizer for deposition of films by a vacuum evaporation process is described which features a cylindrical diode with hollow cylindrical cathode consisting of six tungsten wire rings outside and a hollow cylindrical anode inside. The cathode is surrounded by a cylindrical shield. The anode is either a molybdenum wire ring for thermionic evaporation of material or a cylindrical molybdenum wire mesh for evaporation of material by a radial beam of slow electrons. The former method of producing a discharge in the vapor of the material to be deposited has been found to be more efficient, with optimum ion accelerating potential at the substrate holder depending on the material (-4.5 to -5.0 kV for Al or Cu, -3 kV for Cr, with ion current density 0.2-0.25 and 0.04 mA/cm² respectively), than the latter method requiring cathode potential of -400 V to produce electron current of 150-180 mA under a vacuum of the order of 10⁻³ Pa. The device was also used experimentally for directional buildup of Al and CdS films on single crystals such as NaCl. Figures 2, references 6:
2 Russian, 4 Western.
[82-2415]

"CHAMBER FOR STUDY OF MOSSBAUER EFFECT UNDER HYDROSTATIC PRESSURES UP TO 17 KBARS AT TEMPERATURES FROM 78 TO 450 K

Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 81
(manuscript received 30 Jun 80) pp 180-182

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[Abstract] Improvements have been made in a chamber for study of the Mössbauer effect which extends the range of hydrostatic pressures to 17 kbars at temperatures from 78 to 450 K. They include flexible seals around the piston and thus lower friction between the latter and the gasket, which also provides a large safety margin for the beryllium cylinder. A tightening nut around the gasket makes the chamber autonomous so that the Mössbauer effect can be measured directly outside the press. The chamber with a heater coil around the press stands in a steel cup surrounded by a thermostaticizing jacket of insulation, with two holes passing respectively the vibrator rod wrapped in aluminum foil and the outlet tube for the gamma beam also wrapped in aluminum foil. Both 45KhMNFA and ShKh-15 steel with Rockwell C hardness ranging from 40 to 56 are used for components of the chamber. Pure kerosene is used for producing pressures above 10 kbars, a 1:1 mixture of kerosene and transformer oil is used for producing pressures up to 10 kbars. Measurements were made in the Mössbauer transition energy of 23.8 and 14.4 keV respectively. The authors thank V. N. Panyushkin and Ye. V. Kapitanov for the helpful discussions. Figures 2, table 1, references 5: 4 Russian, 1 Western.

[82-2415]

SOME ASPECTS OF ALLOYING STEEL FOR TURBINE AND TURBOGENERATOR RUNNERS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 81 pp 18-21

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[Abstract] An experimental study was made to determine the effect of alloying on the properties of chromium-nickel-molybdenum-vanadium steels used for turbine and turbogenerator wheels. Specimens of these steels with various compositions were smelted in induction and electric-arc furnaces, then cast into 50 kg ingots and forged at 1200-850°C. Preliminary heat treatment consisted of annealing at $Ac_3 + 70^\circ\text{C}$ and tempering at 640-660°C. Final heat treatment consisted of austenitizing at $Ac_3 + 40^\circ\text{C}$ for 1 h, cooling at rates of 10-40,000°C/h, tempering at 500-660°C for 1-100 h, and cooling in water at 70,000°C/h or in a furnace at 10°C/h. The experimental data were processed through correlation and regression analyses with the aid of a WANG 2200T computer, temperature and stress distributions were calculated with the aid of an M 220M computer. The

results indicate that the chromium content must not exceed 3%, to ensure optimum heat transfer and minimum dendritic liquation. At a carbon content varying over the 0.02-0.42% range, 0.8-1.2% Cr and 3-4% Ni with less than 0.1% Si will yield the optimum mechanical characteristics. The optimum content of other carbide forming elements should be 0.4-0.7% Mo and 0.05-0.15% V, with the mechanical strength improved by replacement of 0.05% V with niobium or tantalum. The impurity content should not exceed 0.003% P, 0.010% S, 0.10% Si, 0.0002% Sn, 0.001% As and 0.003% Sb. The alloying elements should generally improve stability of subcooled austenite, they should include those that yield optimum chemical composition of the matrix and optimum precipitation of hardening phases ($M_3C + MC$ or $M_7C_3 + MC$ carbides). The main properties of steel are functionally related to both alloy content and heat treatment. The carbon content in steel for forged and welded steam-turbine runners should be $\leq 0.3\%$ C, with carbon equivalent of the carbon and nickel content $\leq 0.75\% C_{eq}$ and with ratio of chromium content to carbon content within 5-10. On the basis of this study, it is recommended that 34KhN3MA steel be replaced with 20KhN3MFA, 25KhN3MFA, or 36KhN3MFA grades. Besides, 20KhN3MFA steel is recommended for cylinders of hydraulic power presses and 25KhN3MFA steel for forging dies.

Figures 4, table 1, references 14 Russian.

[68-2415]

UDC 620.179.16

MORE RELIABLE ULTRASONIC INSPECTION OF WELDS IN EQUIPMENT OF ATOMIC ELECTRIC POWER PLANTS

Moscow ENERGOMASHINOSTROYENIYE in Russian No 9, Sep 81 pp 15-17

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[Abstract] Ultrasonic inspection is the most effective method of nondestructive inspection of welds between parts made of pearlitic steel, such parts being widely used in atomic electric power plants such as those with RBMK water-graphite channel reactors. Since ultrasonic inspection is laborious, improvements in technique and reliability of manual operation are needed until automatic computerized operation by holographic or other methods will become available. The gist is to ensure a reproducible detection of flaws exceeding some standard threshold, measuring them with minimum error, and determining their nature as well as the allowable level of defectiveness in a given structure. The reliability of ultrasonic inspection depends on subjective factors which must be minimized procedurally and objective factors which must be minimized technologically. It furthermore depends on suppression of interference, both electric and acoustic. As a result of a study made at the Central Scientific Research Institute of Machine Manufacturing Technology, the statistical characteristics of defects in welds have been classified and generalized to cover all types of plane and volume defects of all occurring configurations and distributions. Corrections have also been made in the equipment layout and in the inspection criteria, to ensure accurate detection of the most elusive

flaws: vertical "pipes" with weakness due to underheating and vertical cracks. It has also been established that generally the equivalent defect area is, as an inspection parameter, the most reliable characteristic and the nominal height is the least reliable one. The entire spectrum of defectiveness indicators can be subdivided into three ranges (lower, middle, higher) in terms of information content. A new indicator, the "acoustic form factor", with an appropriate inspection algorithm has been proposed by this author jointly with V. Ye. Belyy of the All-Union Scientific Research Institute of Bridge Construction (Leningrad Institute of Railroad Transportation Engineers) as a basis for revision of existent norms for quality evaluation. Meanwhile, the "Tsiklon" electron-acoustic instrument has been developed for "tandem" measurement by the echo-mirror method and recording on electrothermal paper. Tables 3, references 5 Russian.

[68-2415]

UDC 621.472:621.383.5

THERMOELECTRIC EFFICIENCY OF MATERIALS BASED ON COBALT MONOSILICIDE

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 19 Jun 80) pp 18-21

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[Abstract] Cobalt monosilicide is a low-cost material with excellent physico-chemical properties, except for a low thermoelectric efficiency. A theoretical study was made to evaluate the dependence of its thermoelectric efficiency on various partial effects associated with bipolar diffusion and the high thermal conductivity of the crystal lattice. In a computer-aided numerical analysis on the basis of the 2-band model with parabolic energy bands, the width of the band overlap varying linearly with temperature, and thermal conductivity varying inversely with temperature, the thermoelectric efficiency and thermoelectric power were calculated as functions of temperature. Furthermore, thermal emf and electrical conductivity were calculated as functions of hydrostatic pressure. The results indicate that decreasing the lattice parameter of the CoSi cell by means of elastic strains could appreciably raise the thermoelectric efficiency of materials based on this semimetallic compound. Figures 6; references 7: 4 Russian, 1 Polish, 2 Western.

[48-2415]

FEASIBILITY OF USING LOW-COST CONCENTRATOR SYSTEMS IN MODULES OF PHOTOELECTRIC POWER PLANTS

Tashkent GELIOTEKHNIKA in Russian No 4, Jul-Aug 81
(manuscript received 4 May 81) pp 10-13

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[Abstract] In a feasibility study of concentrator system cost reduction, a uniaxial array of sun tracking mirrors was used with nGaAs-pGaAs-pAl_xGa_{1-x}As solar cells in a solar electric power plant on ground. The surface finish of paraboloidal mirrors 50 cm in diameter was produced by either lap polishing or "mollishing", [G. Ya. Umarov, A. K. Alimov et al., GELIOTEKHNIKA, No 6, 1969], the cost of the latter process being two orders of magnitude lower. The efficiency of "mollished" mirrors was, however, found to be lower than that of polished ones and the difference to increase with higher solar flux concentration factor. Measurements of the reflection coefficient in monochromatic light ($\lambda = 0.63 \mu\text{m}$) from an LG-75M gas laser revealed no significant difference in this respect between polished and "mollished" mirrors. Rather, the larger size of the focal spot and the asymmetric energy distribution in the focal plane were found to lower the efficiency. Improving the efficiency of these mirrors thus appears to be a technological problem worth delving into, inasmuch as a power density as high as 9 W/cm² is attainable with such mirrors and their economic advantages have already been established. Increasing the size of the solar cell appears to be a better solution than adjusting the shape of the focal spot. The authors thank A. K. Alimov for supplying the specimens of mirrors and N. F. Ovechkin for assisting in the experiment. Figures 3, references 2: 1 Russian, 1 Western.

[48-2415]

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